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THESIS

OPTIMIZING RESOURCE ALLOCATION WHEN ESTABLISHING A MULTINATIONAL MARITIME LOGISTICS FORCE

by

John D. Lape

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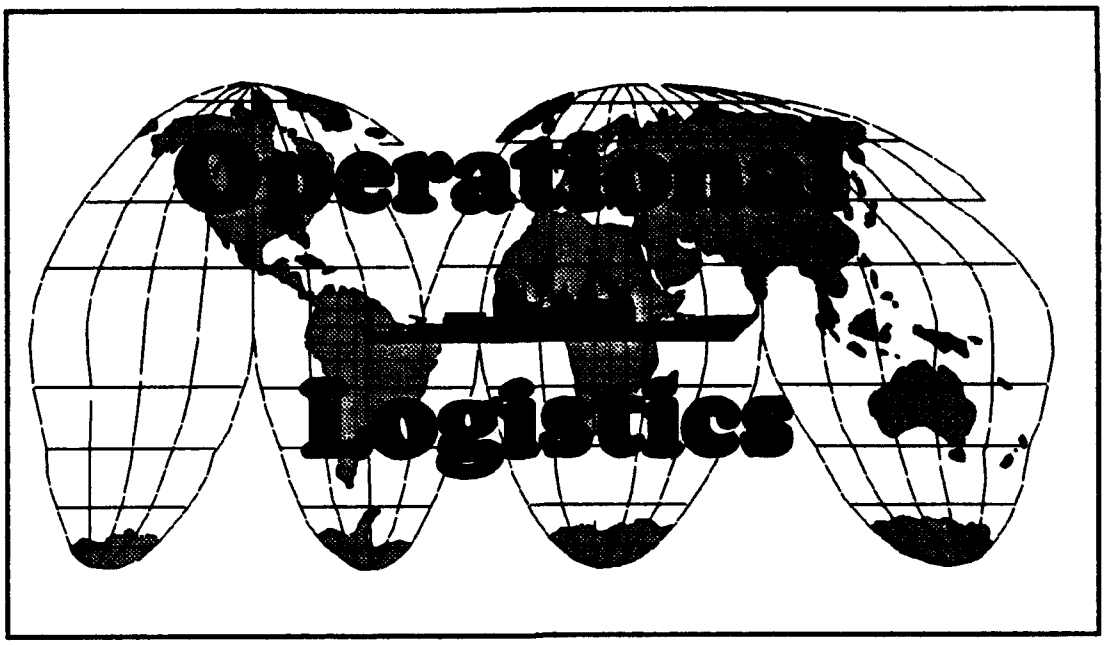
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The **LOGISTICS ALLOCATION PROGRAM TO EVALUATE THE AVAILABILITY OF RESOURCES (LAPEAR)** presented in this thesis is a decision support system to aid NATO commanders in determining where to get resources to support a Multinational Maritime Logistics Force (MNLF). The problem is constrained by the structure of the desired logistics support organization and the amount of resources member nations are willing to provide in specific operation areas. For long range planning purposes, this model helps identify potential resource shortages in support of conflicts in specific operating areas. When a crisis situation develops, the model can help NATO commanders to quickly decide which nations should be tasked to provide resources.

LAPEAR is easy to operate on a PC using the MS-DOS operating system and General Algebraic Modeling System (GAMS) modeling software with an associated solver. For realistic scenarios, LAPEAR provides optimal allocation plans in less than a minute.

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OPTIMIZING RESOURCE ALLOCATION WHEN ESTABLISHING A MULTINATIONAL MARITIME LOGISTICS FORCE

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ABSTRACT

The **LOGISTICS ALLOCATION PROGRAM TO EVALUATE THE AVAILABILITY OF RESOURCES (LAPEAR)** presented in this thesis is a decision support system to aid NATO commanders in determining where to get resources to support a Multinational Maritime Logistics Force (MNLF). The problem is constrained by the structure of the desired logistics support organization and the amount of resources member nations are willing to provide in specific operation areas. For long range planning purposes, this model helps identify potential resource shortages in support of conflicts in specific operating areas. When a crisis situation develops, the model can help NATO commanders to quickly decide which nations should be tasked to provide resources.

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THESIS DISCLAIMER

The reader is cautioned that the computer program developed in this research may not have been exercised for all cases of interest. While every effort has been made, within the time available, to ensure that the functions are free of computational and logic errors, they cannot be considered fully verified or validated. Any application of these functions without additional verification and validation of the code is at the risk of the user.

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EXECUTIVE SUMMARY

When a crisis response situation develops requiring North Atlantic Treaty Organization (NATO) naval forces, a logistics network must be established to provide support. That network is the Multinational Maritime Logistics Force (MNLF) presided over by the Multinational Maritime Force Logistics Commander (MNLC). The LOGISTICS ALLOCATION PROGRAM TO EVALUATE THE AVAILABILITY OF RESOURCES (LAPEAR) developed in this thesis is a decision support system to aid NATO commanders and the MNLC in determining where to get resources to support the MNLF.

The MNLC is responsible for establishing facilities consisting of an Advanced Logistics Support Site (ALSS) and one or more Forward Logistics Sites (FLS). An ALSS is a primary transshipment point for maritime logistics support which possesses full capabilities for storage, consolidation and transfer of Petroleum, Oil, and Lubricants (POL), supplies and munitions, and has airlift and sealift throughput capacity. An FLS has airfield facilities and is located in close proximity to the main operating area to permit forward staging of services and throughput of high priority cargo and personnel.

Various types of equipment and personnel are required to establish these MNLF components. NATO's member nations provide differing quantities and types of assets based upon

the perceived threat, operating area, and location of logistics sites, as well as their abilities and commitments.

For operational planning purposes, logistics personnel must evaluate these inputs and determine if they are adequate to meet various contingencies. The main purpose of this analysis is to determine if all the necessary logistics sites could be equipped with all the required personnel and equipment. Then, given that these requirements can be met, the NATO commander's preferences can be considered as to which nations provide what type of support. This decision process is easily modeled as a transportation problem where the goal is to get all required assets from various stock points to their destinations at minimum cost.

LAPEAR makes this analysis process much easier to perform. It allows the user to easily input data and contingency scenarios, converts the data to a form usable by an optimization model, accesses the optimization model and produces output reports in a useful format.

LAPEAR can be used for long-range planning and in response to an actual crisis situation. For long-range planning, this model can be run with various combinations of operation areas, MNLF structures, and logistics site size requirements to determine potential resource shortages. When reacting to a crisis situation, this model provides timely recommendations for determining resource support.

LAPEAR is able to produce an allocation plan very quickly. For testing purposes, NATO provided a representative, unclassified data set. Allocation plans were generated in less than a minute for all "realistic" scenarios tested, and no scenarios tested took more than two minutes.

In conclusion, LAPEAR provides valuable assistance in analyzing the availability and allocation of support items for the NATO Multinational Maritime Logistics Force. This quick, responsive logistics tool can evaluate multiple requirements scenarios for either contingency planning or actual crisis response. Its ability to operate on a PC, interactive format, and easy-to-read reports make LAPEAR a valuable analytical tool for NATO logistics personnel.

I. INTRODUCTION

A. THE MULTINATIONAL MARITIME FORCE LOGISTICS CONCEPT

The North Atlantic Treaty Organization (NATO) is a collective defensive alliance of 16 nations designed to prevent and repel aggression [Ref. 1]. When a situation requiring naval support by NATO forces (a Multinational Maritime Force) develops, a logistics network must be established to provide support for this force. This logistics network is the Multinational Maritime Logistics Force (MNLF). The coordinator responsible for the MNLF is the Multinational Maritime Force Logistics Commander (MNLC) and attending staff consisting of personnel from the member nations compiled for the specific contingency. The MNLC is responsible for establishing facilities consisting of an Advanced Logistics Support Site (ALSS) and one or more Forward Logistics Sites (FLS).

The MNLC is a shore-based commander responsible for performing logistics planning, coordination and support for the afloat Multinational Maritime Force, and has operational control of assigned shore-based logistics support personnel and assets, including the ALSS and FLS.

The ALSS is a location in the theater of operations used as the primary transshipment point for maritime logistics support. An ALSS possesses full capabilities for storage,

consolidation and transfer of Petroleum, Oil, and Lubricants (POL), supplies and munitions in support of forward deployed maritime forces during crisis operations. An ALSS, with seaport and airfield facilities nearby, is located within the theater of operations but not in close proximity to the main operating or crisis area. It must possess the throughput capacity required to accommodate incoming inter-theater and outgoing intra-theater airlift and sealift. When fully activated, the ALSS should consist of facilities and services provided by a host nation, and augmented by support personnel, equipment and services provided by the nations contributing maritime forces.

The FLS is a location with airfield facilities which provides logistics support to maritime forces within the theater of operations during crisis response operations. An FLS may be located in close proximity to the main operating or crisis area to permit forward staging of services and throughput of high priority cargo and personnel. In providing maritime logistics support, FLS capabilities may range from very austere to those of an ALSS including a supporting seaport.

Various types of equipment and personnel are required to establish these components of the logistics support network. NATO's member nations provide inputs as to which of the necessary resources they would be willing to provide. For operational planning purposes, logistics personnel must

evaluate these inputs and determine if they are adequate to meet various contingencies. The Logistics Allocation Program for Evaluating the Availability of Resources (LAPEAR) developed in this thesis is a program that can help determine the availability of assets for potential contingencies and which nations should provide the support for specific logistics sites.

B. THESIS MOTIVATION

In 1992, NATO logistics personnel at Supreme Allied Command, Atlantic (SACLANT), were involved in developing the Multinational Logistics Support Concept. An important part of this development process is to determine if all shore-based logistic requirements can be met with the resources provided by the member nations. The next stage of the process is to determine which nations should be tasked to provide these assets, and if and where shortages exist.

The type of analysis required for this problem was being done manually on an "as-needed" basis. For example, a specific scenario could be generated for determination of requirements availability. NATO logistics personnel would then take the support inputs from the member nations and determine which countries should provide support. This task is not as straight forward as one might assume. Many nations provide differing quantities and types of assets based upon the perceived threat, operating area, and location of

logistics sites. Subjective factors, such as the desires of the NATO commander, also enter into the decision process. Distance from the providing nation to the logistics site should also be considered. These factors can be enumerated to some extent, but make it more difficult to perform analysis without aid of an appropriate model and computing equipment.

C. PROGRAM DESCRIPTION

LAPEAR was developed as a decision support system to help with this analysis problem. LAPEAR provides an interface which allows the user to easily enter and change required data, run the optimization model, and review the model's output. The optimization model was developed using the General Algebraic Modeling System (GAMS) [Ref. 2] with the associated BDMLP solver [Ref. 3].

LAPEAR can be used both for long-range planning and in response to an actual crisis situation. For long-range planning, this model can be run with various combinations of operation areas, MNLF structures, and logistic site size requirements to determine potential resource shortages. Identifying and resolving shortages found in the planning stages will enhance the ability to meet all requirements in event of an actual crisis. When reacting to a crisis situation, this model provides timely recommendations for determining resource support.

LAPEAR is designed in a general format such that changes in potential operation areas, resource requirements, site locations, and member-nations can easily be made by altering only the data files.

LAPEAR runs on a 386/486 computer using the MS-DOS operating system. GAMS, with the associated BDMLP solver, is required to perform the optimization part of the program.

D. THESIS ORGANIZATION

Chapter II discusses the formulation of the optimization model. Chapter III gives an overview of how the analysis is actually performed through use of a sample allocation problem. Chapter IV reviews the major contributions of LAPEAR and recommendations for future consideration.

The program code for the GAMS optimization model is included as Appendix A. Sample data used for the example discussed in Chapter III can be found in Appendix B followed by the associated output reports in Appendix C. Appendix D contains the LAPEAR User's Guide.

II. MODEL FORMULATION

The main purpose of the MNLF analysis is to determine if sufficient personnel and equipment exist for all of the necessary logistics sites. Then, given that these requirements can be met, the NATO commander's preferences can be considered as to which nations provide what type of support. This decision process is easily modeled as a transportation problem where the goal is to get all required assets from various stock points to their destinations at minimum cost. Transportation problems are described in most basic linear programming texts[1].

A. CONSTRAINTS OF A LOGISTICS SUPPORT PLAN

1. Resource Requirements

Each site requires a certain amount of various types of assets. These requirements may vary from site to site and are specified by the NATO Operation Plan.

2. Resources Available from Nations to Specific Areas

Each nation submits to NATO a list of assets it would be willing to provide in support of the MNLF. However, some nations may put conditions on their support depending on the

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[1]For example, LINEAR PROGRAMMING AND EXTENSIONS, George B. Dantzig, Princeton University Press, 1963, pp. 299-315.

locations of the support sites or the specific threat which exists.

3. Total Resources Available from Each Nation

Since there could be more than one support site being used at a given time, this resource constraint accounts for the total amount of each type of support available to NATO from each nation at one time.

B. INDICES

i -- type of support needed,

j -- potential nations to provide support,

k -- location where support is required.

C. PARAMETERS

$SHORTPEN_{i,k}$ -- penalty for having a shortage of support *i* in location *k*;

$INVENTORY_{i,j,k}$ -- amount of support *i* available to location *k* by nation *j*,

$MAXINV_{i,j}$ -- maximum amount of support *i* available from nation *j*,

$COST_{i,j,k}$ -- cost of providing support *i* to location *k* by nation *j*,

$REQUIREMNT_{i,k}$ -- amount of support i needed at location k.

D. VARIABLES

$AMT_{i,j,k}$ -- amount of support i provided by nation j to location k,

$SHORTAGE_{i,k}$ -- shortages of support i in location k.

E. FORMULATION

Find $AMT_{i,j,k}$ and $SHORTAGE_{i,k}$ to minimize

$$\sum_{i,j,k} (AMT_{i,j,k} \times COST_{i,j,k}) + \sum_{i,k} (SHORTAGE_{i,k} \times SHORTPEN_{i,k})$$

Subject to

$$\sum_{j} AMT_{i,j,k} + SHORTAGE_{i,k} = REQUIREMNT_{i,k} \quad \forall\, i,k \tag{1}$$

$$\sum_{k} AMT_{i,j,k} \leq MAXINV_{i,j} \quad \forall\, i,j \tag{2}$$

$$AMT_{i,j,k} \leq INVENTORY_{i,j,k} \quad \forall\, i,j,k \tag{3}$$

1. Objective Function

The objective function minimizes the cost of supplying resources from source to destination. A shortage penalty, based on the type of support and destination, is added to the objective for failing to satisfy required demand. By minimizing the total cost in this model an acceptable allocation of resources should be produced.

2. Development of Cost Parameter

The transportation cost in this model is primarily dependent upon the preferences of the NATO commander as to which nation provides what type of support to which location. Given equal preferences, the next factor considered is the distance from the providing nation to the site. The greater the distance, the higher the associated cost.

3. Resource Requirements

Each logistics support site must have the proper amount of equipment and personnel to carry out its mission, or a shortage occurs (see formulation constraint (1)). These assets will be different between the types of sites (MNLCs, ALSSs, FLSs), but can also differ between similar site-types at different locations.

4. Resource Availability

There are two constraints on resource availability. First, there is a maximum amount of each type of support a nation can provide at a given time (constraint (2)). This is especially important when there is more than one set of

logistics support sites being established. The second constraint (constraint (3)) is required to account for the member nations' political aims. Several nations have specified amounts of support they would be willing to provide contingent on the specific site location or the operating area of the battle group. For example, one nation might be willing to provide a helicopter detachment and air cargo handlers to an ALSS supporting operations in the Baltic Sea, but would not supply them for operations elsewhere. Another nation may be willing to provide a medical unit to an FLS located in Spain or Portugal, but nowhere else. This constraint will usually be the most limiting in allocating support to the various sites.

5. Alternative Model Formulation

Since each type of support is independent of the others, this optimization model could have been simplified (and made more efficient) by only analyzing one type of support at a time. This would require running the model once for each type of support. However, since the solution time for the current model is small (less than a minute real time on a realistic data set), this alternative method is not necessary.

III. SOLVING THE ASSET ALLOCATION PROBLEM

This chapter uses a sample logistics allocation problem to help discuss how LAPEAR develops an allocation plan for an MNLF. Appendix B contains an example set of all the data required for this analysis. The types of data include potential logistics support site locations, site personnel and equipment requirements, inventory of assets available from each nation, prioritization of sites in case of shortages, prioritization of nations to provide support to specific sites, and distances from the nations to the various site locations. This sample data set, while fictional in content, is representative of the size and complexity expected of the actual data. The following paragraphs discuss how this information is used in producing an optimal allocation plan. For details on how to perform actual steps using LAPEAR, refer to the user's guide located in Appendix D.

A. SAMPLE SCENARIO

Assume NATO logistics personnel have been tasked with providing logistics support for two naval forces: one is to be operating in the Baltic Sea (designated BA), the other in the eastern portion of the Mediterranean Sea (designated AE). Both areas are to be supported by separate MNLFs, each consisting of an MNLC, ALSS, and FLS. The data contained in Appendix B indicate that the cities listed in Table 1 may be

used to host specific logistics sites in these areas of operations.

	MNLC	ALSS	FLS
BA	STAV	STAV	STAV
	ZEEB	ZEEB	ZEEB
	DENH	DENH	DENH
	KIEL	KIEL	KIEL
	PRES	PRES	PRES
	PORT	PORT	PORT
			FRIE
			ESBJ
AE	SOUD	SOUD	SOUD
	INCI	INCI	INCI
	AKSA	AKSA	AKSA

Table 1. Cities available to host support sites supporting specified areas of operations.

Based upon the available choices, a command decision is made to establish the sites as follows: in the Baltics, the MNLC and ALSS will be at the city STAV, with the FLS at the city FRIE; in the Mediterranean, the MNLC and ALSS will be in SOUD, with the FLS at INCI. Table 2 shows the site names associated with this selection of support site locations.

BAMNLCSTAV
BAALSSSTAV
BAFLSSFRIE
AEMNLCSOUD
AEALSSSOUD
AEFLSSINCI

Table 2. Logistics support sites required for the MNLFs established in this example.

1. Site Requirements

The data in Appendix B indicates that all MNLCs, ALSSs and FLSs have the same requirements of personnel and equipment. Table 3 lists these requirements.

		MNLC	ALSS	FLS
MCDR	(MNLC Commander)	1		
MADM	(MNLC Admin Staff)	1		
AOPS	(Air Operations Staff)	1		
SOPS	(Surface Ops Staff)	1		
MOPS	(Medical Staff)	1		
VODS	(Helo Detachments)	4		
CODS	(COD Dets)	1		
TAIR	(Intra-Theater Air Det)		1	
SHTL	(Shuttle Ship)		1	
ACDR	(ALSS Commander)		1	
AACD	(ALSS Air Cargo Det)		3	
ASCD	(ALSS Surface Cargo Det)		3	
ACOM	(ALSS Communications Det)		1	
AMED	(ALSS Medical Det)		1	
FCDR	(FLS Commander)			1
FACD	(FLS Air Cargo Det)			2
FSCD	(FLS Surface Cargo Det)			2
FCOM	(FLS Communications Det)			1
FMED	(FLS Medical Det)			1

Table 3. Standard Logistics Support Site Requirements.

2. Available Resources

Appendix B contains the specific data on which nations are willing to provide support to which logistics sites, and how much of each type of support they can supply. Table 4 highlights those nations willing to provide support to these areas of operations.

BALTICS	EASTERN MEDITERRANEAN
BE (Belgium)	GE
DE (Denmark)	GR (Greece)
GE (Germany)	IT (Italy)
NE (Netherlands)	PO (Portugal)
NR (Norway)	SP (Spain)
UK (United Kingdom)	TU (Turkey)
US (United States)	UK
	US

Table 4. Nations willing to provide support to affected areas of operations.

3. Shortage Penalty

The shortage penalty determines which sites have priority for items that are not available in sufficient quantity. Appendix B data shows that there is no preference between sites in the different MNLFs, but it is most important to fill the MNLC first, then the ALSS, and then the FLS.

4. Priority

Table 5 shows the priorities as to which nations provide support to which operating areas. The highest priority in this scenario is a "2", with lowest priority of "9".

	BA	AE
BE	2	--
DE	2	--
GE	2	9
GR	--	2
IT	--	2
NE	2	--
NR	2	--
PO	--	6
SP	--	6
TU	--	2
UK	4	4
US	6	4

Table 5. Priority values indicating which nations are preferred to provide assets to different areas of operations.

5. Distance

If more than one nation is willing to provide a specific type of support to a site, and each nation has equal priority, the support will be taken from the nation closest to the support site. These distances are included in Appendix B.

B. OUTPUT REPORTS

GAMS generates the desired output information after the optimization model runs. LAPEAR takes this information and formats it logically for easier review. For this scenario, it took less than one minute to run the optimization model and generate the reports. The reports provide: information regarding which nation should provide what support to which location; support sites where shortages exist and potential alternatives for filling them; the amount of each type of support that each nation has left after the required support items are allocated; and, how much support each nation is providing. Included below are portions of the reports generated from the sample scenario, with discussions of how some of the results were reached. The complete reports are contained in Appendix C.

1. Assignment of Support by Source

ASSIGNMENT OF SUPPORT BY SOURCE

SOURCE	DESTINATION	SUPPORT	AMOUNT
BE			
	BAALSSSTAV	AACD	1
	BAALSSSTAV	ASCD	1
DE			
	BAMNLCSTAV	MADM	1
	BAMNLCSTAV	SOPS	1
	BAMNLCSTAV	MOPS	1
	BAMNLCSTAV	TAIR	1
	BAALSSSTAV	AACD	1
	BAALSSSTAV	ASCD	1
	BAALSSSTAV	AMED	1
	BAFLSSFRIE	FACD	1
	BAFLSSFRIE	FSCD	1

This report lists the amount of each type of support provided to the various sites by each nation. For example, Belgium is providing one unit of support item AACD to the site BAALSSSTAV.

To test these results for "common sense", review the data for providing support item AACD to BAALSSSTAV. The INVENTORY file shows that Norway is the only nation from Table 4 not able to provide this item. Table 5 shows that Belgium, Denmark, Germany, and Netherlands each have equal priority to provide support to this site. The MAXIMUM INVENTORY file shows that each of these nations can provide only one unit of AACD. The DISTANCE file shows that of these four nations,

Belgium, Denmark and the Netherlands are the closest to STAV. Since there are three units of AACD required at this ALSS (from Table 3), it makes sense that Belgium should be supplying this item.

2. Assignment of Support by Destination

ASSIGNMENT OF SUPPORT BY DESTN

	SUPPORT	SOURCE	AMOUNT
BAMNLCSTAV			
	MCDR	NE	1
	MADM	DE	1
	AOPS	NE	1
	SOPS	DE	1
	MOPS	DE	1
	VODS	GE	1
	VODS	NE	1
	VODS	UK	1
	CODS	US	1
	TAIR	DE	1
	SHTL	NE	1

This report is simply a sorted version of the previous report and lists the amount of each type of support each nation will be providing to a specific site. For example, site BAMNLCSTAV receives one unit of support item MCDR from the Netherlands.

3. Listing of Shortages by Destination, and Potential Sources to Fill Shortages

```
LISTING OF SHORTAGES BY DESTN

     BAMNLCSTAV      VODS          1


  POTENTIAL SOURCES TO FILL SHORTAGES

SUPPORT      SOURCE       AMT AVAILABLE

 VODS        IT                1
```

This report lists the requirements that could not be filled, and any nation that could potentially provide that support. In this example, site BAMNLCSTAV is short one unit of support item VODS. Italy has one unit of VODS available, but apparently was not initially willing to provide it to site BAMNLCSTAV.

Table 3 shows that there would be a total of eight VODS required to set up two MNLFs. The MAXIMUM INVENTORY file shows that there are eight units of VODS available. The INVENTORY file, however, shows that Italy will only provide their VODS to the AW operating area. As a result, there is a shortage of one unit of VODS. In determining which site should suffer the shortage, examine Table 5. Germany and the Netherlands have the highest priorities of concern for providing their assets to the Baltic area, so their two units

of VODS go there. The United Kingdom has the next highest priority, equal for both areas, so is indifferent. The United States has a higher priority for the Eastern Mediterranean than the Baltics, so its four units of VODS go there. Since AEMNLCSOUD now has all its required units of VODS, the United Kingdom sends its unit of VODS to BAMNLCSTAV. As a result, BAMNLCSTAV is short one unit of VODS.

4. List of Remaining Assets

LISTING OF REMAINING ASSETS TO GIVEN AREA, AND MAX ASSETS REMAINING

SOURCE	SUPPORT	DESTIN	AVAIL TO DESTN	MAX AVAILABLE
BE	MADM	BAMNLCSTAV	1	1
BE	SOPS	BAMNLCSTAV	1	1
BE	MOPS	BAMNLCSTAV	1	1
BE	TAIR	BAMNLCSTAV	1	1
BE	AMED	BAMNLCSTAV	0	1
BE	FACD	BAMNLCSTAV	0	1
BE	FSCD	BAMNLCSTAV	0	1
BE	FMED	BAMNLCSTAV	0	1

This report lists all assets each nation has remaining after the allocation is performed, and to which sites the nation is willing to provide the assets. For example, Belgium has one unit of support item MADM left and is willing to give it to site BAMNLCSTAV. Belgium also has one unit of FMED left, but is not willing to give it to BAMNLCSTAV.

5. Participating Nations

PARTICIPATING NATIONS

NATION	UNITS PROVIDED
BE	2
DE	9
GE	6
GR	8
IT	3
NE	8
TU	9
UK	4
US	6

This report is a summary of the total number of support items each nation is providing to the MNLFs in the given scenario. It gives a quick review of which nations are participating, and to what extent they are providing support.

C. USE OF INFORMATION FROM OUTPUT REPORTS

The allocation plan generated for this example passes the "common sense" test in that it complies with the inventory and requirement constraints, and current preferences, listed in the data set. It must be stated, however, that the recommended asset allocation plan is based upon user inputs of availability and assigned cost. Due to the subjectivity of the costs, the results should always be tested to insure that the NATO Commander's desires are being met. The assigned values in the "preference" data can easily be changed if

necessary to more accurately reflect the commander's desires, and the model re-run.

IV. FINDINGS, RECOMMENDATIONS AND CONCLUSIONS

A. FINDINGS

As stated in the introduction, NATO is still in the early stages of implementing the MNLF concept. Inputs from all of the nations have not yet been received, so no formal analysis has been done. If the complex allocation plans required to determine which nations provide what types of support to which logistics support sites had to be formulated manually, it is easy to see how it could take a good deal of time to get a workable asset distribution plan for just one scenario. LAPEAR is able to produce a very good distribution plan in less than two minutes that includes a set of output reports to help the staff make quick, informed decisions.

The sample MNLF used in Chapter III was based upon a fictional but representative (in size and complexity) data set provided by NATO. Initialization of the sample data base took approximately six hours to complete, but this is generally a one-time investment. After the initial data base is established, future data changes and parameter updates can be done in a matter of minutes.

The LAPEAR optimization model was tested by NATO logistics personnel using data from an actual exercise conducted in early 1993. The allocation plan produced by the model was very similar to the plan that was actually used. The planners

were pleased with the results of the model, and enthusiastic about its potential for use in MNLF planning. Although LAPEAR cannot be fully validated without actual data, the test scenarios run on the representative data produced allocation plans that all passed the "common sense" test when compared to the raw data.

B. RECOMMENDATIONS FOR FURTHER REVIEW

LAPEAR was created with tools that the author was familiar with: GAMS and QUICKBASIC. There are, however, some disadvantages and/or constraining factors with these systems that should be noted.

1. Program Procurement Expense

GAMS software and the BDMLP solver currently cost approximately $3,400. If multiple copies of this program are desired, costs could quickly escalate. A stand-alone computer program could be written to perform the interface functions and the actual optimization without use of external software. The cost of this program could be less than the cost of purchasing a few copies of GAMS and BDMLP.

2. Limitations of QUICKBASIC

The size of the data sets for this allocation problem is larger than the array limitations in QUICKBASIC, so a less efficient means of manipulating data had to be used. A

different programming language could potentially overcome this deficiency and make the interface more user-friendly.

3. Operating System Limitations

Some of the functions performed by LAPEAR make use of functions provided by the MS-DOS operating system. Since all operating systems are not the same, this program may not work with other systems. By making the interface perform these functions without depending on the operating system, the program would be more exportable.

C. CONCLUSIONS

LAPEAR is a computer program that can provide valuable assistance in analyzing the availability and allocation of support items for the NATO Multinational Logistics Force. It quickly sorts through all of the available assets, support site locations where the assets are required, and priority hierarchy to develop an allocation plan in a very short time. The quick optimization time decreases the amount of time required for operational planning when many scenarios must be evaluated. In addition to operational planning assistance, LAPEAR is also able to provide a quick response when required for crisis planning. Its ability to operate on a PC, interactive format, and easy-to-read reports make LAPEAR a valuable analytical tool for NATO logistics personnel.

APPENDIX A

OPTIMIZATION MODEL SOURCE CODE

```
$TITLE LAPEAR Logistics Allocation Program to Evaluate
the Availability of Resources


$ONTEXT

          LAPEAR is a basic transportation model used to
        evaluate the availability of and a potential
        distribution plan for logistics assets.



                PROGRAMMER:     John D. Lape, LCDR, USN
                DATE:           September, 1993


$OFFTEXT

$OFFUPPER
$OFFSYMXREF OFFSYMLIST OFFUELLIST


OPTIONS
     LIMROW    =    15
     LIMCOL    =    15
     SOLPRINT  =    ON
     ITERLIM   =    2000
     ;


SETS

SUPPORT  types of support needed at the logistics sites
/
$INCLUDE SUPPORTD.L@P
/

SOURCE potential sources of support (nations willing to
provide)
/
$INCLUDE SOURCE.SET
```

```
/

DESTN destination where support is required (specific
logistics site)
/
$INCLUDE DESTN.SET
/
;


TABLE INVENTORY(*,*,SUPPORT) amount of source available per
area
$INCLUDE INVNTRY.L@P

TABLE MAXINV(*,SUPPORT) total amount of source available
$INCLUDE MAXINV.L@P

TABLE MILES(*,*) distances from sources to destinations
$INCLUDE DISTANC.L@P

TABLE PRIORITY(*,*,SUPPORT) priority for assigning source to
destination
$INCLUDE PRIORITY.L@P

PARAMETER COST(*,*,SUPPORT) associated costs based on priority
and distance;
COST(DESTN,SOURCE,SUPPORT) = PRIORITY(DESTN,SOURCE,SUPPORT)
                           + (MILES(DESTN,SOURCE)/1000);

TABLE SHORTPENIN(*,SUPPORT) cost of having shortage of an item
at a location
$INCLUDE SHORTPEN.L@P

PARAMETER SHORTPEN(DESTN,SUPPORT) adjusted shortage penalty;
SHORTPEN(DESTN,SUPPORT) = SHORTPENIN(DESTN,SUPPORT) * 1000;

TABLE REQUIREMNT(*,SUPPORT) amount of source needed

$INCLUDE RQTS.L@P


POSITIVE VARIABLE
     AMT(SUPPORT,SOURCE,DESTN) amount of support provided;

POSITIVE VARIABLE
    SHORTAGE(DESTN,SUPPORT) shortages of support in an area;

FREE VARIABLE Z objective function value;
```

```
EQUATIONS

DEMAND(SUPPORT,DESTN) meet demand for destn in area

SUPPLY(SOURCE,DESTN,SUPPORT) ensures capacity of source to
area not exceeded

SUPPLY2(SOURCE,SUPPORT) ensures total capacity of source not
exceeded

OBJECTIVE objective function
;


DEMAND(SUPPORT,DESTN) $ (REQUIREMNT(DESTN,SUPPORT) GT 0)..
          SUM(SOURCE $(INVENTORY(SOURCE,DESTN,SUPPORT) GT 0),
               AMT(SUPPORT,SOURCE,DESTN))
           + SHORTAGE(DESTN,SUPPORT)
           =E=  REQUIREMNT(DESTN,SUPPORT);

SUPPLY(SOURCE,DESTN,SUPPORT)
     $ ((REQUIREMNT(DESTN,SUPPORT) GT 0)
     AND (INVENTORY(SOURCE,DESTN,SUPPORT) GT 0))..
        AMT(SUPPORT,SOURCE,DESTN)
        =L= INVENTORY(SOURCE,DESTN,SUPPORT);

SUPPLY2(SOURCE,SUPPORT) ..
        SUM(DESTN,AMT(SUPPORT,SOURCE,DESTN)
           $ ((REQUIREMNT(DESTN,SUPPORT) GT 0) AND
             (INVENTORY(SOURCE,DESTN,SUPPORT) GT 0)))
         =L= MAXINV(SOURCE,SUPPORT);

OBJECTIVE .. Z =E= SUM((SUPPORT,SOURCE,DESTN),
                      ((AMT(SUPPORT,SOURCE,DESTN)
                        $ ((REQUIREMNT(DESTN,SUPPORT) GT 0)
                      AND
                        INVENTORY(SOURCE,DESTN,SUPPORT) GT 0)))
                     * COST(DESTN,SOURCE,SUPPORT)))
                  +
                SUM((SUPPORT,DESTN),((SHORTAGE(DESTN,SUPPORT)
                     $ (REQUIREMNT(DESTN,SUPPORT) GT 0))
                      * SHORTPEN(DESTN,SUPPORT)));

MODEL LAPEAR /ALL/;

OPTION LP = BDMLP;

SOLVE LAPEAR USING LP MINIMIZING Z;

OPTION DECIMALS=0;
```

```
PARAMETER   MAXREMASST(SOURCE,SUPPORT)   max   support   still
available per source;
    MAXREMASST(SOURCE,SUPPORT)$(MAXINV(SOURCE,SUPPORT) GT 0)
    = MAXINV(SOURCE,SUPPORT)
    - SUM((DESTN),AMT.L(SUPPORT,SOURCE,DESTN));

PARAMETER REMASSETS(SUPPORT,DESTN,SOURCE) support available to
area after
assignment;

REMASSETS(SUPPORT,DESTN,SOURCE)
    $(INVENTORY(SOURCE,DESTN,SUPPORT) GT 0)
         = MIN((INVENTORY(SOURCE,DESTN,SUPPORT)
         - AMT.L(SUPPORT,SOURCE,DESTN)),
         MAXREMASST(SOURCE,SUPPORT));



$ONTEXT

        CREATE OUTPUT REPORTS

$OFFTEXT


FILE REP1/REPORT1.OUT/;
PUT REP1;
PUT //"ASSIGNMENT OF SUPPORT BY SOURCE"//;

PUT /"SOURCE     DESTINATION   SUPPORT   AMOUNT"/;
  LOOP (SOURCE $(SUM((SUPPORT,DESTN),
    AMT.L(SUPPORT,SOURCE,DESTN)) GT 0),
    PUT //SOURCE.TL:5/;
    LOOP((DESTN,SUPPORT)$(AMT.L(SUPPORT,SOURCE,DESTN) GT 0),
         PUT"            ", DESTN.TL:10,
       "       ", SUPPORT.TL:5, "     ",
         AMT.L(SUPPORT,SOURCE,DESTN):5:0/;
    );
  );
```

```
FILE REP2/REPORT2.OUT/;
PUT REP2;
PUT //"ASSIGNMENT OF SUPPORT BY DESTN"//;
PUT "              SUPPORT   SOURCE    AMOUNT"/;
LOOP (DESTN,
   PUT //DESTN.TL:10/;
   LOOP((SUPPORT,SOURCE)
          $(AMT.L(SUPPORT,SOURCE,DESTN) GT 0),
          PUT"              ", SUPPORT.TL:5,
        "     ", SOURCE.TL:5,
          "     ",AMT.L(SUPPORT,SOURCE,DESTN):5:0/;
   );
);


FILE SHORTREP/SHORTAGE.OUT/;
PUT SHORTREP;
PUT /"LISTING OF SHORTAGES BY DESTN"//;
IF((SUM((DESTN,SUPPORT),SHORTAGE.L(DESTN,SUPPORT)) EQ 0),
 PUT///"***  ALL REQUIREMENTS ARE MET  ***"//;
 );


LOOP ((DESTN,SUPPORT)$(SHORTAGE.L(DESTN,SUPPORT) GT 0),
      PUT "     ",DESTN.TL:10,"     ",SUPPORT.TL:5,
      "     ",SHORTAGE.L(DESTN,SUPPORT):5:0/;
);

PUT///"  POTENTIAL SOURCES TO FILL SHORTAGES"/;


PUT/"SUPPORT     SOURCE      AMT AVAILABLE"/;

LOOP (SUPPORT,

   IF(((SUM(SOURCE,MAXREMASST(SOURCE,SUPPORT)) GT 0) AND
      (SUM(DESTN,SHORTAGE.L(DESTN,SUPPORT)) GT 0)),
        PUT /SUPPORT.TL:5/;
        IF((SUM(DESTN,SHORTAGE.L(DESTN,SUPPORT)) GT 0),
           LOOP((SOURCE)
               $(SUM(DESTN,SHORTAGE.L(DESTN,SUPPORT)) GT 0)
                 AND (MAXREMASST(SOURCE,SUPPORT) GT 0)),
                   PUT "             "SOURCE.TL:5,
                   "    ",
                   MAXREMASST(SOURCE,SUPPORT):5:0/;
            );
        );
    );
  );
```

```
FILE REMASS/REMASS.OUT/;
PUT REMASS;
PUT//"LISTING OF REMAINING ASSETS TO GIVEN AREA, AND MAX
ASSETS REMAINING"/;

PUT//"SOURCE   SUPPORT   DESTINATION   AVAILABLE TO DESTN
MAXIMUM AVAILABLE"//;
LOOP ((SOURCE,DESTN),

     LOOP(SUPPORT $(MAXREMASST(SOURCE,SUPPORT) GT 0),
         PUT SOURCE.TL:5,"     ",SUPPORT.TL:5,
           "      ", DESTN.TL:10,
             "            ",
             REMASSETS(SUPPORT,DESTN,SOURCE):3:0,
             "                  ",
             MAXREMASST(SOURCE,SUPPORT):3:0/;
       );
 );

FILE STATS/STATS.OUT/;
PUT STATS;
PUT//"PARTICIPATING NATIONS"/;

PUT //"     NATION        UNITS PROVIDED"/;

LOOP(SOURCE,
 IF((SUM((SUPPORT,DESTN),AMT.L(SUPPORT,SOURCE,DESTN)) GT 0),
      PUT "      ",SOURCE.TL:5, "          ",
          SUM((SUPPORT,DESTN),
          AMT.L(SUPPORT,SOURCE,DESTN)):5:0/
 );
);
```

APPENDIX B

SAMPLE MNLF DATA SET

LOGISTICS SITES

	WL	EL	NL	BA	IB	AW	AE
MNLC'S	NORF	PORT	VAER	STAV	AZOR	CART	SOUD
	HALI	KEFL	PRES	ZEEB	LISB	SIGO	INCI
		PRES	KEFL	DENH	ROTA	LISB	[illegible]SA
			KVER	KIEL	LASP	ROTA	
			STAV	PRES			
				PORT			
ALSS'S	NORF	PORT	VAER	STAV	AZOR	CART	SOUD
	HALI	KEFL	PRES	ZEEB	LISB	SIGO	INCI
		PRES	KEFL	DENH	ROTA	LISB	AKSA
			KVER	KIEL	LASP	ROTA	
			STAV	PRES			
				PORT			
FLS'S	NORF	PORT	ANDO	FRIE	AZOR	CART	SOUD
	HALI	KEFL	BODO	STAV	LISB	SIGO	INCI
		PRES	VAER	DENH	ROTA	LISB	AKSA
		SUMB	SUMB	ZEEB	LASP	ROTA	
			PRES	ESBJ			
			KVER	PRES			
			BROE	KIEL			
			EVEN	PORT			
			STAV				

INVENTORY

	MNLC									ALSS					FLS			
	MCDR	MADW	ACPS	SOPS	MOPS	VODS	COCS	AIR	S-T	ACDR	AACE	ASOS	ACOM	AMED	FCDR	FACE	FSOS	FCOM	FMED
BEWL	0	1	0	1	1	0	0	0	0	0	0	1	1	1	0	1	1	1	1
BEEL	0	1	0	1	1	0	0	0	0	0	0	1	1	1	0	1	1	1	1
BENL	0	1	0	1	1	0	0	0	0	0	0	1	1	1	0	1	1	1	1
BEBA	0	1	0	1	1	0	0	0	0	0	0	1	1	1	0	1	1	1	1
CAWL	1	1	0	0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1
CAEL	1	1	0	0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1
CANL	1	1	0	0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1
DEWL	0	1	0	1	1	0	0	1	0	0	1	1	1	1	0	1	1	0	1
DEEL	0	1	0	1	1	0	0	1	0	0	1	1	1	1	0	1	1	0	1
DENL	0	1	0	1	1	0	0	1	0	0	1	1	1	1	0	1	1	0	1
DEBA	0	1	0	1	1	0	0	1	0	0	1	1	1	1	0	1	1	0	1
GEWL	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
GEEL	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
GENL	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
GEBA	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
GEIB	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
GEAW	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
GEAE	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
GRAE	0	1	0	1	1	0	0	1	0	0	1	1	1	0	1	0	1	1	1
ITIB	0	1	0	1	1	0	0	1	0	0	1	1	1	0	1	0	1	1	0
ITAW	0	1	0	1	1	0	0	1	0	0	1	1	1	0	1	0	1	1	0
ITAE	0	1	0	1	1	0	0	1	0	0	1	1	1	0	1	0	1	1	0
NEWL	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
NEEL	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
NENL	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
NEBA	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
NRNL	0	1	0	1	1	0	0	0	1	1	0	1	0	1	1	0	1	1	1
NRBA	0	1	0	1	1	0	0	0	1	1	0	1	0	1	1	0	1	1	1
POWL	0	1	0	0	0	0	0	1	0	0	1	1	0	0	0	1	1	1	0
POEL	0	1	0	0	0	0	0	1	0	0	1	1	0	0	0	1	1	1	0
PONL	0	1	0	0	0	0	0	1	0	0	1	1	0	0	0	1	1	1	0
POIB	0	1	0	0	0	0	0	1	0	0	1	1	0	0	0	1	1	1	0
POAW	0	1	0	0	0	0	0	1	0	0	1	1	0	0	0	1	1	1	0
POAE	0	1	0	0	0	0	0	1	0	0	1	1	0	0	0	1	1	1	0
SPWL	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	1	1	1
SPEL	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	1	1	1
SPNL	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	1	1	1
SPIB	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	1	1	1
SPAW	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	1	1	1
SPAE	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	1	1	1
TUIB	1	1	0	1	0	0	0	0	1	1	0	1	1	1	1	0	1	1	1
TUAW	1	1	0	1	0	0	0	0	1	1	0	1	1	1	1	0	1	1	1
TUAE	1	1	0	1	0	0	0	0	1	1	0	1	1	1	1	0	1	1	1
UKWL	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
UKEL	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
UKNL	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
UKBA	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
UKIB	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
UKAW	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
UKAE	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
USWL	1	1	1	1	1	2	2	8	6	1	1	1	1	1	2	2	2	2	2
USEL	1	1	1	1	1	2	2	8	6	1	1	1	1	1	2	2	2	2	2
USNL	1	1	1	1	1	2	2	8	6	1	1	1	1	1	2	2	2	2	2
USBA	1	1	1	1	1	2	2	8	6	1	1	1	1	1	2	2	2	2	2
USIB	1	1	1	1	1	2	2	8	6	1	1	1	1	1	2	2	2	2	2
USAW	1	1	1	1	1	2	2	8	6	1	1	1	1	1	2	2	2	2	2
USAE	1	1	1	1	1	2	2	8	6	1	1	1	1	1	2	2	2	2	2

MAXIMUM INVENTORY

	MNEC									ALSE								
	MCOR	MADM	AOPS	SOPS	MOPS	VOOS	COOS	TAIF	SHTL	ACOM	AACC	ASCC	ACOM	AMED	FCOR	FACC	FSCC	FCOM	FMED
BE	0	1	0	1	1	0	0	*	0	0	1	1	0	1	0	1	*	0	*
CA	1	1	0	0	1	0	0	0	0	1	1	1	1	1	1	1	*	*	*
DE	0	1	0	1	1	0	0	*	0	0	1	1	0	1	0	1	*	0	*
GE	1	1	1	1	1	1	0	*	1	1	1	1	1	1	1	1	1	*	*
GR	0	1	0	1	1	0	0	*	0	0	1	1	0	1	0	1	*	*	1
IT	0	1	0	1	1	0	0	*	0	0	1	1	0	1	0	1	1	0	*
NE	1	1	1	1	1	1	0	*	1	1	1	1	1	1	1	1	1	*	*
NR	0	1	0	1	1	0	0	0	1	1	0	1	0	1	1	0	1	*	*
PC	0	1	0	0	0	0	0	*	0	0	1	1	0	0	0	1	1	*	0
SP	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	*	*	1
TU	1	1	0	1	0	0	0	0	1	1	0	1	1	1	1	0	1	*	1
UK	1	1	1	1	1	1	0	*	1	1	1	1	1	1	1	1	1	*	*
US	2	2	2	2	2	4	4	8	6	2	2	2	2	2	3	3	3	3	3

	MNLC																			
	MODF	MADM	AOPS	SOPS	MOPS	VODS	COOS	AIR	S-T	ACOF	AACC	ASOC	ACOV	AMEL	FCOF	FACC	FSOC	FCOV	FVEL	
BEWL	0	1	0	1	1	0	0	1	0	0	1	1	1	0	1	0	1	1	1	1
BEEL	0	1	0	1	1	0	0	1	0	0	1	1	1	0	1	0	1	1	1	1
BENL	0	1	0	1	1	0	0	1	0	0	1	1	1	0	1	0	1	1	1	1
BEBA	0	1	0	1	1	0	0	1	0	0	1	1	1	0	1	0	1	1	1	1
CAWL	1	1	0	0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1
CAEL	1	1	0	0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1
CANL	1	1	0	0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1
DEWL	0	1	0	1	1	0	0	1	0	0	0	1	1	0	1	0	1	1	0	1
DEEL	0	1	0	1	1	0	0	1	0	0	0	1	1	0	1	0	1	1	0	1
DENL	0	1	0	1	1	0	0	1	0	0	0	1	1	0	1	0	1	1	0	1
DEBA	0	1	0	1	1	0	0	1	0	0	0	1	1	0	1	0	1	1	0	1
GEWL	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
GEEL	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
GENL	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
GEBA	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
GEIB	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
GEAW	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
GEAE	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
GRAE	0	1	0	1	1	0	0	1	0	0	1	1	1	0	1	0	1	1	1	1
ITIB	0	1	0	1	1	0	0	1	0	0	1	1	1	0	1	0	1	1	0	1
ITAW	0	1	0	1	1	0	0	1	0	0	1	1	1	0	1	0	1	1	0	1
ITAE	0	1	0	1	1	0	0	1	0	0	1	1	1	0	1	0	1	1	0	1
NEWL	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
NEEL	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
NENL	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
NEBA	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
NRNL	0	1	0	1	1	0	0	0	1	1	0	1	1	0	1	0	1	1	1	1
NRBA	0	1	0	1	1	0	0	0	1	1	0	1	1	0	1	0	1	1	1	1
POWL	0	1	0	0	0	0	0	1	0	0	1	1	1	0	0	0	1	1	1	0
POEL	0	1	0	0	0	0	0	1	0	0	1	1	1	0	0	0	1	1	1	0
PONL	0	1	0	0	0	0	0	1	0	0	1	1	1	0	0	0	1	1	1	0
POIB	0	1	0	0	0	0	0	1	0	0	1	1	1	0	0	0	1	1	1	0
POAW	0	1	0	0	0	0	0	1	0	0	1	1	1	0	0	0	1	1	1	0
POAE	0	1	0	0	0	0	0	1	0	0	1	1	1	0	0	0	1	1	1	0
SPWL	0	0	0	1	1	0	0	0	0	0	0	0	1	0	1	0	1	1	1	1
SPEL	0	0	0	1	1	0	0	0	0	0	0	0	1	0	1	0	1	1	1	1
SPNL	0	0	0	1	1	0	0	0	0	0	0	0	1	0	1	0	1	1	1	1
SPIB	0	0	0	1	1	0	0	0	0	0	0	0	1	0	1	0	1	1	1	1
SPAW	0	0	0	1	1	0	0	0	0	0	0	0	1	0	1	0	1	1	1	1
SPAE	0	0	0	1	1	0	0	0	0	0	0	0	1	0	1	0	1	1	1	1
TUIB	1	1	0	1	0	0	0	0	1	1	0	1	1	1	1	1	1	0	1	1
TUAW	1	1	0	1	0	0	0	0	1	1	0	1	1	1	1	1	1	0	1	1
TUAE	1	1	0	1	0	0	0	0	1	1	0	1	1	1	1	1	1	0	1	1
UKWL	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
UKEL	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
UKNL	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
UKBA	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
UKIB	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
UKAW	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
UKAE	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
USWL	1	1	1	1	1	2	2	8	8	1	1	1	1	1	1	2	2	2	2	2
USEL	1	1	1	1	1	2	2	8	8	1	1	1	1	1	1	2	2	2	2	2
USNL	1	1	1	1	1	2	2	8	8	1	1	1	1	1	1	2	2	2	2	2
USBA	1	1	1	1	1	2	2	8	8	1	1	1	1	1	1	2	2	2	2	2
USIB	1	1	1	1	1	2	2	8	8	1	1	1	1	1	1	2	2	2	2	2
USAW	1	1	1	1	1	2	2	8	8	1	1	1	1	1	1	2	2	2	2	2
USAE	1	1	1	1	1	2	2	8	8	1	1	1	1	1	1	2	2	2	2	2

DISTANCE (100 KM'S)

	BE	CA	DE	GE	GR	IT	NE	NR	PO	SP	TU	UK	US
NORF	85	15	88	88	105	95	87	95	72	75	110	80	0
HALI	72	0	75	75	90	75	70	75	50	55	100	65	20
PORT	8	65	12	13	14	20	9	14	20	20	45	0	80
KEFL	28	50	28	30	50	40	28	25	33	33	65	15	75
PRES	8	65	12	13	14	20	9	14	20	20	45	0	80
SUMB	8	65	12	13	14	20	9	14	20	20	45	0	80
VAER	13	75	5	15	30	25	10	0	30	30	40	14	95
KVER	13	75	5	15	30	25	10	0	30	30	40	14	95
STAV	13	75	5	15	30	25	10	0	30	30	40	14	95
ANDO	13	75	5	15	30	25	10	0	30	30	40	14	95
BODO	13	75	5	15	30	25	10	0	30	30	40	14	95
BROE	13	75	5	15	30	25	10	0	30	30	40	14	95
EVEN	13	75	5	15	30	25	10	0	30	30	40	14	95
ZEEB	0	72	8	5	20	12	3	13	18	18	30	8	85
DENH	3	70	5	2	20	12	0	10	20	20	30	9	87
KIEL	20	90	5	0	20	15	20	30	40	40	30	14	105
FRIE	20	90	5	0	20	15	20	30	40	40	30	14	105
ESBJ	8	75	0	5	30	18	5	5	40	40	35	12	88
AZOR	18	50	45	45	55	50	20	30	0	25	45	20	72
LISB	18	50	40	40	50	40	20	30	0	5	40	20	72
ROTA	18	55	40	40	30	20	20	30	10	0	35	20	75
LASP	18	55	40	40	30	20	20	30	10	0	35	20	75
CART	18	55	40	40	30	20	20	30	10	0	35	20	75
SIGO	12	75	18	15	10	0	12	25	25	18	20	20	95
SOUD	20	90	30	20	0	10	20	30	32	25	20	14	105
INCI	30	100	35	30	10	20	30	40	40	35	0	45	110
AKSA	30	100	35	30	10	20	30	40	40	35	0	45	110

PRIORITIES

	WL	EL	NL	BA	IB	AW	AE
BE	9	2	6	2			
CA	2	9	9				
DE	6	6	2	2			
GE	9	2	2	2	6	4	9
GR							2
IT					6	2	2
NE	9	6	2	2			
NR			2	2			
PO	9	6	9		2	2	6
SP	9	6	9		2	2	6
TU					9	6	2
UK	4	2	2	4	4	4	4
US	2	4	6	6	4	4	4

SHORTAGE PENALTY	
MNLC	8
ALSS	6
FLS	4

APPENDIX C

SAMPLE OUTPUT REPORTS

A. Assignment of Support by Source.

This report lists the amount of each type of support provided to the various sites by each nation.

ASSIGNMENT OF SUPPORT BY SOURCE

SOURCE	DESTINATION	SUPPORT	AMOUNT
BE			
	BAALSSSTAV	AACD	1
	BAALSSSTAV	ASCD	1
DE			
	BAMNLCSTAV	MADM	1
	BAMNLCSTAV	SOPS	1
	BAMNLCSTAV	MOPS	1
	BAMNLCSTAV	TAIR	1
	BAALSSSTAV	AACD	1
	BAALSSSTAV	ASCD	1
	BAALSSSTAV	AMED	1
	BAFLSSFRIE	FACD	1
	BAFLSSFRIE	FSCD	1
GE			
	BAMNLCSTAV	VODS	1
	BAFLSSFRIE	FCDR	1
	BAFLSSFRIE	FACD	1
	BAFLSSFRIE	FSCD	1
	BAFLSSFRIE	FCOM	1
	BAFLSSFRIE	FMED	1
GR			
	AEMNLCSOUD	MADM	1
	AEMNLCSOUD	SOPS	1
	AEMNLCSOUD	MOPS	1
	AEMNLCSOUD	TAIR	1
	AEALSSSOUD	AACD	1
	AEALSSSOUD	AMED	1
	AEFLSSINCI	FACD	1
	AEFLSSINCI	FSCD	1

IT			
	AEALSSSOUD	AACD	1
	AEALSSSOUD	ASCD	1
	AEFLSSINCI	FACD	1
NE			
	BAMNLCSTAV	MCDR	1
	BAMNLCSTAV	AOPS	1
	BAMNLCSTAV	VODS	1
	BAMNLCSTAV	SHTL	1
	BAALSSSTAV	ACDR	1
	BAALSSSTAV	AACD	1
	BAALSSSTAV	ASCD	1
	BAALSSSTAV	ACOM	1
TU			
	AEMNLCSOUD	MCDR	1
	AEMNLCSOUD	SHTL	1
	AEALSSSOUD	ACDR	1
	AEALSSSOUD	ASCD	1
	AEALSSSOUD	ACOM	1
	AEFLSSINCI	FCDR	1
	AEFLSSINCI	FSCD	1
	AEFLSSINCI	FCOM	1
	AEFLSSINCI	FMED	1
UK			
	BAMNLCSTAV	VODS	1
	AEMNLCSOUD	AOPS	1
	AEALSSSOUD	AACD	1
	AEALSSSOUD	ASCD	1
US			
	BAMNLCSTAV	CODS	1
	AEMNLCSOUD	VODS	4
	AEMNLCSOUD	CODS	1

B. Assignment of Support by Destination

This report is simply a sorted version of the previous report and lists the amount of each type of support each nation will be providing to a specific site.

ASSIGNMENT OF SUPPORT BY DESTN

	SUPPORT	SOURCE	AMOUNT
BAMNLCSTAV			
	MCDR	NE	1
	MADM	DE	1
	AOPS	NE	1
	SOPS	DE	1
	MOPS	DE	1
	VODS	GE	1
	VODS	NE	1
	VODS	UK	1
	CODS	US	1
	TAIR	DE	1
	SHTL	NE	1
BAALSSSTAV			
	ACDR	NE	1
	AACD	BE	1
	AACD	DE	1
	AACD	NE	1
	ASCD	BE	1
	ASCD	DE	1
	ASCD	NE	1
	ACOM	NE	1
	AMED	DE	1
BAFLSSFRIE			
	FCDR	GE	1
	FACD	DE	1
	FACD	GE	1
	FSCD	DE	1
	FSCD	GE	1
	FCOM	GE	1
	FMED	GE	1

AEMNLCSOUD			
	MCDR	**TU**	**1**
	MADM	**GR**	**1**
	AOPS	**UK**	**1**
	SOPS	**GR**	**1**
	MOPS	**GR**	**1**
	VODS	**US**	**4**
	CODS	**US**	**1**
	TAIR	**GR**	**1**
	SHTL	**TU**	**1**
AEALSSSOUD			
	ACDR	**TU**	**1**
	AACD	**GR**	**1**
	AACD	**IT**	**1**
	AACD	**UK**	**1**
	ASCD	**IT**	**1**
	ASCD	**TU**	**1**
	ASCD	**UK**	**1**
	ACOM	**TU**	**1**
	AMED	**GR**	**1**
AEFLSSINCI			
	FCDR	**TU**	**1**
	FACD	**GR**	**1**
	FACD	**IT**	**1**
	FSCD	**GR**	**1**
	FSCD	**TU**	**1**
	FCOM	**TU**	**1**
	FMED	**TU**	**1**

C. Listing of Shortages by Destination, and Potential Sources to Fill Shortages

This report lists the requirements that could not be filled, and any nation that could potentially provide that support.

LISTING OF SHORTAGES BY DESTN

BAMNLCSTAV VODS 1

POTENTIAL SOURCES TO FILL SHORTAGES

SUPPORT	SOURCE	AMT AVAILABLE
VODS	IT	1

D. List of Remaining Assets to a Given Area, and the Maximum Amount of Assets Remaining

This report lists all assets each nation has remaining after the allocation is performed, and to which sites the nation is willing to provide the assets.

LISTING OF REMAINING ASSETS TO GIVEN AREA, AND MAX ASSETS REMAINING

SOURCE	SUPPORT	DESTINATION	AVAILABLE TO DESTN	MAXIMUM AVAILABLE
BE	MADM	BAMNLCSTAV	1	1
BE	SOPS	BAMNLCSTAV	1	1
BE	MOPS	BAMNLCSTAV	1	1
BE	TAIR	BAMNLCSTAV	1	1
BE	AMED	BAMNLCSTAV	0	1
BE	FACD	BAMNLCSTAV	0	1
BE	FSCD	BAMNLCSTAV	0	1
BE	FMED	BAMNLCSTAV	0	1
BE	MADM	BAALSSSTAV	0	1
BE	SOPS	BAALSSSTAV	0	1
BE	MOPS	BAALSSSTAV	0	1
BE	TAIR	BAALSSSTAV	0	1
BE	AMED	BAALSSSTAV	1	1
BE	FACD	BAALSSSTAV	0	1
BE	FSCD	BAALSSSTAV	0	1
BE	FMED	BAALSSSTAV	0	1
BE	MADM	BAFLSSFRIE	0	1
BE	SOPS	BAFLSSFRIE	0	1
BE	MOPS	BAFLSSFRIE	0	1
BE	TAIR	BAFLSSFRIE	0	1
BE	AMED	BAFLSSFRIE	0	1
BE	FACD	BAFLSSFRIE	1	1
BE	FSCD	BAFLSSFRIE	1	1
BE	FMED	BAFLSSFRIE	1	1
BE	MADM	AEMNLCSOUD	0	1
BE	SOPS	AEMNLCSOUD	0	1
BE	MOPS	AEMNLCSOUD	0	1
BE	TAIR	AEMNLCSOUD	0	1
BE	AMED	AEMNLCSOUD	0	1
BE	FACD	AEMNLCSOUD	0	1
BE	FSCD	AEMNLCSOUD	0	1
BE	FMED	AEMNLCSOUD	0	1
BE	MADM	AEALSSSOUD	0	1
BE	SOPS	AEALSSSOUD	0	1
BE	MOPS	AEALSSSOUD	0	1
BE	TAIR	AEALSSSOUD	0	1
BE	AMED	AEALSSSOUD	0	1
BE	FACD	AEALSSSOUD	0	1
BE	FSCD	AEALSSSOUD	0	1
BE	FMED	AEALSSSOUD	0	1
BE	MADM	AEFLSSINCI	0	1
BE	SOPS	AEFLSSINCI	0	1
BE	MOPS	AEFLSSINCI	0	1
BE	TAIR	AEFLSSINCI	0	1
BE	AMED	AEFLSSINCI	0	1
BE	FACD	AEFLSSINCI	0	1
BE	FSCD	AEFLSSINCI	0	1
BE	FMED	AEFLSSINCI	0	1
CA	MCDR	BAMNLCSTAV	0	1

CA	MADM	BAMNLCSTAV	0	1
CA	MOPS	BAMNLCSTAV	0	1
CA	ACDR	BAMNLCSTAV	0	1
CA	AACD	BAMNLCSTAV	0	1
CA	ASCD	BAMNLCSTAV	0	1
CA	ACOM	BAMNLCSTAV	0	1
CA	AMED	BAMNLCSTAV	0	1
CA	FCDR	BAMNLCSTAV	0	1
CA	FACD	BAMNLCSTAV	0	1
CA	FSCD	BAMNLCSTAV	0	1
CA	FCOM	BAMNLCSTAV	0	1
CA	FMED	BAMNLCSTAV	0	1
CA	MCDR	BAALSSSTAV	0	1
CA	MADM	BAALSSSTAV	0	1
CA	MOPS	BAALSSSTAV	0	1
CA	ACDR	BAALSSSTAV	0	1
CA	AACD	BAALSSSTAV	0	1
CA	ASCD	BAALSSSTAV	0	1
CA	ACOM	BAALSSSTAV	0	1
CA	AMED	BAALSSSTAV	0	1
CA	FCDR	BAALSSSTAV	0	1
CA	FACD	BAALSSSTAV	0	1
CA	FSCD	BAALSSSTAV	0	1
CA	FCOM	BAALSSSTAV	0	1
CA	FMED	BAALSSSTAV	0	1
CA	MCDR	BAFLSSFRIE	0	1
CA	MADM	BAFLSSFRIE	0	1
CA	MOPS	BAFLSSFRIE	0	1
CA	ACDR	BAFLSSFRIE	0	1
CA	AACD	BAFLSSFRIE	0	1
CA	ASCD	BAFLSSFRIE	0	1
CA	ACOM	BAFLSSFRIE	0	1
CA	AMED	BAFLSSFRIE	0	1
CA	FCDR	BAFLSSFRIE	0	1
CA	FACD	BAFLSSFRIE	0	1
CA	FSCD	BAFLSSFRIE	0	1
CA	FCOM	BAFLSSFRIE	0	1
CA	FMED	BAFLSSFRIE	0	1
CA	MCDR	AEMNLCSOUD	0	1
CA	MADM	AEMNLCSOUD	0	1
CA	MOPS	AEMNLCSOUD	0	1
CA	ACDR	AEMNLCSOUD	0	1
CA	AACD	AEMNLCSOUD	0	1
CA	ASCD	AEMNLCSOUD	0	1
CA	ACOM	AEMNLCSOUD	0	1
CA	AMED	AEMNLCSOUD	0	1
CA	FCDR	AEMNLCSOUD	0	1
CA	FACD	AEMNLCSOUD	0	1
CA	FSCD	AEMNLCSOUD	0	1
CA	FCOM	AEMNLCSOUD	0	1
CA	FMED	AEMNLCSOUD	0	1
CA	MCDR	AEALSSSOUD	0	1
CA	MADM	AEALSSSOUD	0	1
CA	MOPS	AEALSSSOUD	0	1
CA	ACDR	AEALSSSOUD	0	1
CA	AACD	AEALSSSOUD	0	1
CA	ASCD	AEALSSSOUD	0	1
CA	ACOM	AEALSSSOUD	0	1
CA	AMED	AEALSSSOUD	0	1
CA	FCDR	AEALSSSOUD	0	1
CA	FACD	AEALSSSOUD	0	1
CA	FSCD	AEALSSSOUD	0	1

CA	FCOM	AEALSSSOUD	0	1
CA	FMED	AEALSSSOUD	0	1
CA	MCDR	AEFLSSINCI	0	1
CA	MADM	AEFLSSINCI	0	1
CA	MOPS	AEFLSSINCI	0	1
CA	ACDR	AEFLSSINCI	0	1
CA	AACD	AEFLSSINCI	0	1
CA	ASCD	AEFLSSINCI	0	1
CA	ACOM	AEFLSSINCI	0	1
CA	AMED	AEFLSSINCI	0	1
CA	FCDR	AEFLSSINCI	0	1
CA	FACD	AEFLSSINCI	0	1
CA	FSCD	AEFLSSINCI	0	1
CA	FCOM	AEFLSSINCI	0	1
CA	FMED	AEFLSSINCI	0	1
DE	FMED	BAMNLCSTAV	0	1
DE	FMED	BAALSSSTAV	0	1
DE	FMED	BAFLSSFRIE	1	1
DE	FMED	AEMNLCSOUD	0	1
DE	FMED	AEALSSSOUD	0	1
DE	FMED	AEFLSSINCI	0	1
GE	MCDR	BAMNLCSTAV	1	1
GE	MADM	BAMNLCSTAV	1	1
GE	AOPS	BAMNLCSTAV	1	1
GE	SOPS	BAMNLCSTAV	1	1
GE	MOPS	BAMNLCSTAV	1	1
GE	TAIR	BAMNLCSTAV	1	1
GE	SHTL	BAMNLCSTAV	1	1
GE	ACDR	BAMNLCSTAV	0	1
GE	AACD	BAMNLCSTAV	0	1
GE	ASCD	BAMNLCSTAV	0	1

REMAINING PAGES OF THIS REPORT OMITTED

E. Participating Nations

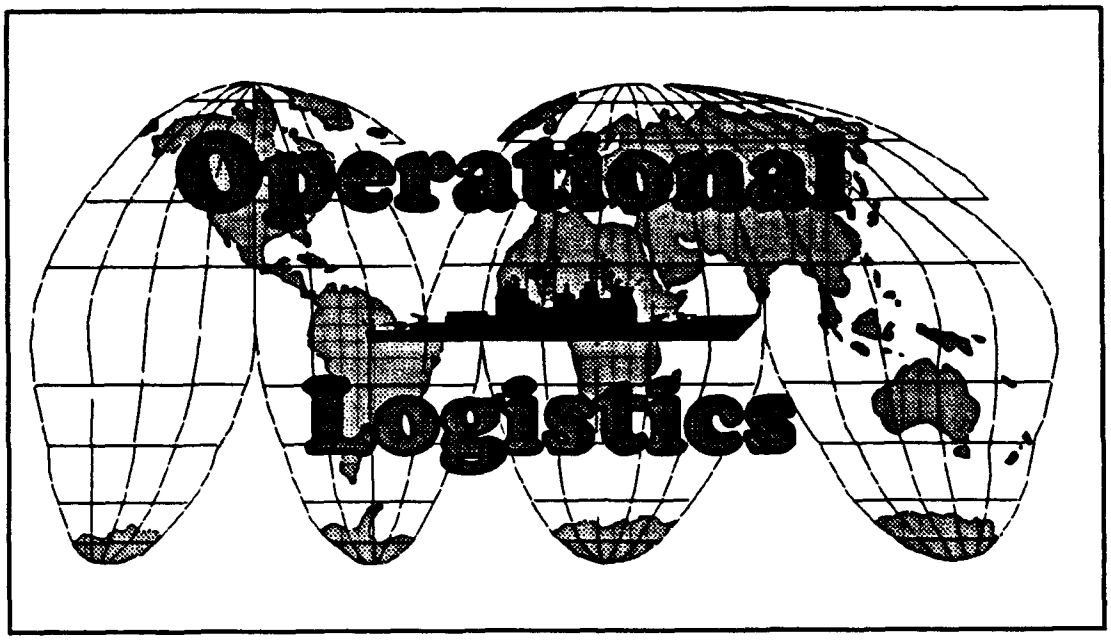
This report is a summary of the total number of support items each nation is providing to the MNLFs in a given scenario.

PARTICIPATING NATIONS

NATION	UNITS PROVIDED
BE	2
DE	9
GE	6
GR	8
IT	3
NE	8
TU	9
UK	4
US	6

APPENDIX D

LAPEAR USER'S GUIDE



LAPEAR

FOR

NATO LOGISTICS SUPPORT SITES

USER'S GUIDE

LCDR JOHN D. LAPE, USN

September, 1993

PREFACE

In 1992, NATO logistics personnel at Supreme Allied Command, Atlantic (SACLANT), were involved in developing a Multinational Logistics Support Concept in support of a Multinational Maritime Force. An important part of this development process was determining if all shore-based logistic requirements could be met with the resources provided by the member nations. The next stage of the process was to determine which nations should be tasked to provide these assets, and if (and where) shortages exist.

The Logistics Allocation Program to Evaluate the Availability of Resources (LAPEAR) was developed as a graduate thesis to assist in multinational logistics support planning. LAPEAR provides an interface for entering and manipulating data, determining feasibilities and possible solutions of various contingencies, and displaying or printing these solutions.

LAPEAR is designed to run on a 386/486 computer with MS-DOS operating system. It currently requires the General Algebraic Modeling System (GAMS) software and the associated BDMLP solver.

This Users Guide is intended to give basic direction in how to use LAPEAR. Additional information on the program development can be found in the related thesis, Optimizing Resource Allocation When Establishing a Multinational Maritime Logistics Force, by Lieutenant Commander John D. Lape, USN. This thesis, completed in September 1993, is available from the Naval Postgraduate School, Monterey, CA.

TABLE OF CONTENTS

I. INTRODUCTION

A. THE MULTINATIONAL MARITIME FORCE LOGISTICS CONCEPT

When a crisis develops in the North Atlantic Treaty Organization (NATO) area of responsibility, a logistics network must be established to provide support for the area of operation. The coordinator is the Multinational Maritime Force Logistics Commander (MNLC) and attending staff. The MNLC is responsible for establishing facilities consisting of an Advanced Logistics Support Site (ALSS) and one or more Forward Logistics Sites (FLS). The Logistics Allocation Program for Evaluating the Availability of Resources (LAPEAR) is a program that can help determine the availability of assets for potential contingencies, and which nations should provide the support for specific logistics sites.

The MNLC is a shore-based commander responsible for performing logistics planning, coordination and support for the afloat Multinational Maritime Force, and to have operational control of assigned shore-based logistics support personnel and assets, including the ALSS and FLS.

The ALSS is a location in the theater of operations used as the primary transshipment point for maritime logistics support. An ALSS possesses full capabilities for storage, consolidation and transfer of Petroleum, Oil, and Lubricants (POL), supplies and munitions in support of forward deployed maritime forces during crisis operations. An ALSS, with seaport and airfield facilities in close proximity, is located within the theater of operations but not in close proximity to the main operating or crisis area, and must possess the throughput capacity required to accommodate incoming inter-theater and outgoing intra-theater airlift and sealift.

The FLS is a location with airfield facilities that provides logistics support to maritime forces within the theater of operations during crisis management operations. An FLS may be located in close proximity to the main operating or crisis area to permit forward staging of services and throughput of high priority cargo and personnel. In providing maritime logistics support, FLS capabilities may range from very austere to those of an ALSS including a supporting seaport. (PROGRAM NOTE: Due to

programming considerations, LAPEAR will use "FLSS" for a Forward Logistics Site.)

B. LAPEAR

LAPEAR can be used both for long-range planning and in response to an actual crisis situation. For long-range planning, it can be run with various combinations of operation areas, MNLC structures, and logistic site size requirements to determine potential resource shortages. Identifying and resolving shortages found in the planning stages will enhance the ability to meet all requirements in event of an actual crisis. When reacting to a crisis situation, this model can provide timely recommendations for determining resource support.

LAPEAR is used to determine resource support based upon the input received from the member nations. The goal of LAPEAR is to provide the "best" way to determine which nations provide which types of support to the various locations (MNLC, ALSS, FLS). The "best" way to do this will depend not only on resource availability, but can also depend on factors such as distance from nations to the sites, political considerations, and commanders' preferences. These factors can be represented as "costs", and minimization of these "costs" should provide the "best" support allocation.

LAPEAR requires a data base using the following types of information:

1. Nations. All nations willing to provide MNLC support.

2. Destinations. All locations where sites may be located, which type of sites may be located at each specific location, and which operating areas the sites may be used to support.

3. Type of support. All types of support (resources) which could be required at the sites.

4. Site resource requirements. The amount of each type of support required at each type of site.

5. Resources available from nations to specific areas. The amount of each type of support each nation is willing to provide to logistics sites in designated areas in support of specific threats.

6. Total resources available from each nation. The total amount of assets available to NATO from a given nation at one time for each type of support.

7. Shortage penalty. A numerical value between 0 and 9 assigned to represent a penalty for not being able to provide a type of support to a specific location. This allows the user to set priorities for allocating assets between MNLCs, ALSSs, and FLSs. A value of 9 is used where a shortage is least acceptable, while a value of 0 is used where a shortage is most acceptable.

8. Priority. A numerical value between 1 and 9 assigned to represent the priority for a specific nation to provide support to a specific site location. A priority value of 1 is for the highest priority assignment, while a value of 9 represents the lowest priority desired.

9. Distance. The distance in hundreds of kilometers from each nation to each location.

C. LAPEAR PROGRAM OVERVIEW

LAPEAR consists of three major parts permitting the user to enter and change the data base, run the optimization model for different scenarios, and view or print output reports.

1. Data Base Management

The data base management section allows the user to create or initialize a new data base, display data in the current data base, or change existing data in the current data base. Initialization of a data base is done by answering a series of questions that will guide the user through all the required data to be input. Additions or deletions of nations, locations, or types of support are made by answering questions similar to the initialization mode. Changes of numerical values in existing data files and displaying of the current files are done by selecting the appropriate menu item that invokes the MS-DOS Text Editor already resident on the user's computer.

2. Optimization Program

This section of LAPEAR allows the user to set a scenario for evaluation and run the GAMS optimization model using the data in the current data base. When running an optimization on a scenario, a suffix code is input by the

user for the output reports so they can be distinguished from output reports of previous scenarios.

3. **Report Printing and Display**

This section allows the user to view the output reports on screen, or make printed copies of them. Reports from previous optimization runs can be printed by changing the suffix code.

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II. INSTALLATION

The program disk contains four files: LAPEAR.EXE, LAPEAR2.EXE, LAPEAR3.EXE, BRUN45.EXE AND LAPEAR.GMS. LAPEAR can be run from the floppy disk, but will run more efficiently from a hard drive. The recommendation is to set up your system as follows:

1. Create a directory named "LAPEAR" and copy the five program files into it.

2. Create a subdirectory under LAPEAR to hold data files. Several data subdirectories may be desired to maintain different data base sets.

3. Ensure that the directory containing the GAMS files is listed in the PATH in the system's CONFIG.SYS file.

4. Ensure that the printer is assigned to port LPT1.

For help in creating directories/subdirectories, changing the PATH statement, and verifying/changing the printer port, refer to the computer's operating manuals.

III. RUNNING LAPEAR

1. From the LAPEAR directory, type LAPEAR. Indicate the applicable computer drive and directories when requested.

2. Initializing Data Base. The first time you run this program, you will immediately be put into the Initialize Data Base subroutine to create your first data base. This input process can take some time, and the time required increases exponentially as the number of nations, locations, and resources expands. When you are ready to initialize a large data set, it is recommended to enter 1 or 2 nations with all locations, types of support, etc.. Then use the "ADD NATION" option in the Change Data Base Menu to put in the rest of the nations.

> IT IS BENEFICIAL TO ENTER ONLY A SMALL NUMBER OF COUNTRIES DURING INITIALIZATION. ONCE THE INITIALIZATION PHASE HAS BEGUN, IT CANNOT BE EXITED PRIOR TO COMPLETION WITHOUT DESTROYING ALL DATA IN THAT DATA BASE.

a. To enter data answer the questions, paying attention to the correct data format. When all required data is entered, you will be returned to the Data Base Menu.

b. Use the Display Data Menu to verify that the data just entered is correct. Use the text editor to make any numerical corrections that may be required, but ENSURE THAT THE NUMBERS ARE ALL KEPT IN ALIGNMENT (RIGHT JUSTIFIED).

3. To run the allocation program, use the appropriate command from the main menu. First, you must set a scenario. This should be the operating area and site locations where you wish to establish Logistics Support Sites. After choosing the scenario, and reviewing it for correctness, run the optimization program.

4. You will be requested to input a suffix for the output reports--this is desired in case you want to run multiple scenarios on the same data base. Without a newly specified suffix, old reports would be overwritten. This suffix will be used later to retrieve the output reports.

5. After the program runs, return to the main menu and view or print the desired reports.

NOTE: If at any time you must exit LAPEAR without using the normal termination options from the menu, hold in the "CTRL" key and then press the "Break" key. However, IF THIS ABNORMAL TERMINATION METHOD IS USED PRIOR TO NORMAL COMPLETION OF ENTERING/CHANGING DATA, THE DATA BASE CAN BE DESTROYED.

IV. MENUS AND DATA ENTRY

A. INTRODUCTION

This chapter will show the menus and types of screens the user should expect to encounter while using LAPEAR. Each menu option will be discussed, as will the types of entries required on the data entry screens.

1. Menus

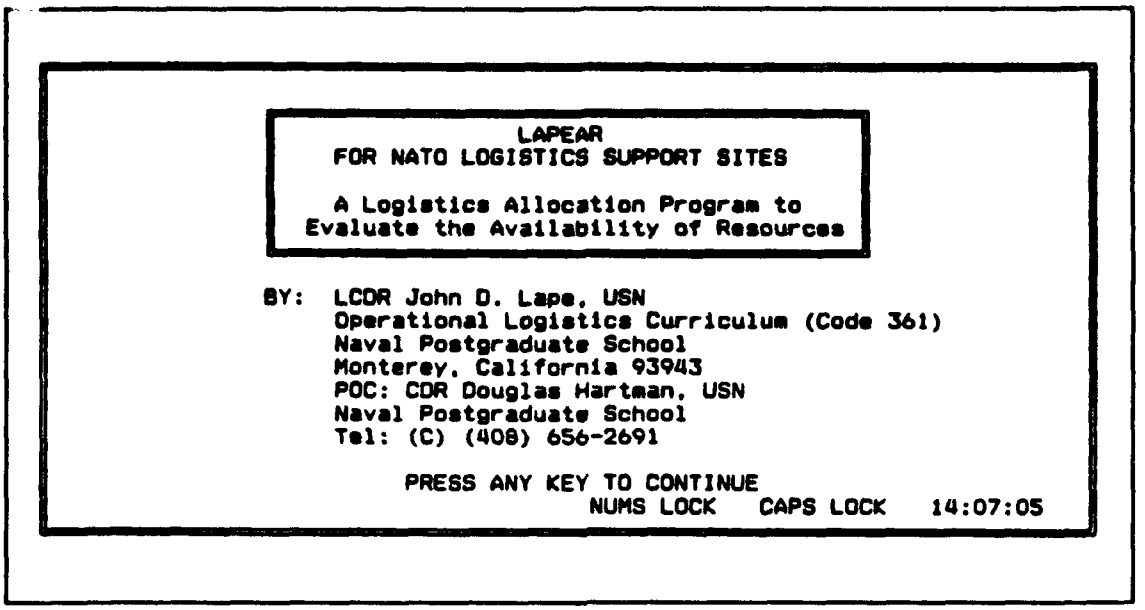
The user presses the key of the letter indicated to the left of the desired action. On several of the menus, the ESCAPE key ("ESC") is used instead of a letter to return to an earlier menu or exit the LAPEAR program. Higher-order menus indicate the current time, and show when "Num Lock" and "Caps Lock" are selected.

2. Entry Screens

The entry screen requests user input of either a specific bit of data, or an answer to a question that permits efficient data input.

B. PROGRAM MENUS AND SCREENS

0.0 Logo Screen



Description: This screen gives the program title, author, and point of contact for further information.

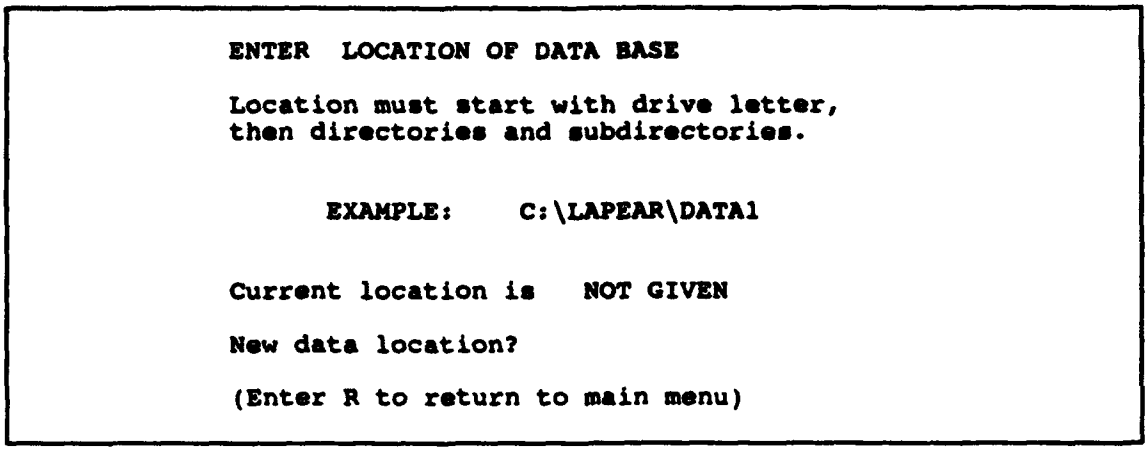
0.1 Program Location Screen

Description: Requests disk drive from which LAPEAR is being run.

Entry: Letter indicating appropriate disk drive. Only the letter is required.

ERROR POTENTIAL: Entering the incorrect disk drive could cause LAPEAR to abort during program operation.

0.2 Data Location Screen

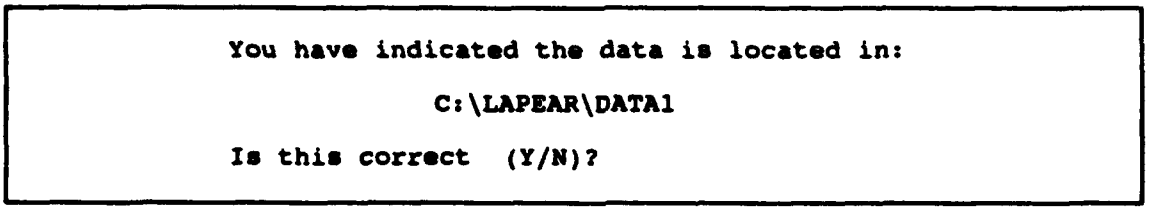


Description: Requests location of the data base desired to be used for the current run of LAPEAR. When initializing a data base, as when using LAPEAR for the first time, enter the location where the data base is desired to be located. If a location has been previously entered, that location will be indicated on this screen.

Entry: For new location, or to give initial location, enter the full directory location as indicated in the example. Do not place a backslash (\) after the last directory/subdirectory name.

If the current location listed is still desired, entering "R" will maintain that location as current and allow the user to continue.

0.2.1 Data Location Verification



Description: Gives user the opportunity to verify the desired data base location.

Entry: Entering "Y" causes LAPEAR to check the indicated location for the appropriate LAPEAR data files. If the data files are located in that directory, the location will be changed as requested. If the data files do not appear in that directory, LAPEAR will generate the Data Location Incomplete/Incorrect screen.

Entering "N" will return the user to the Data Location Screen.

0.2.2 Data Location Incomplete/Incorrect

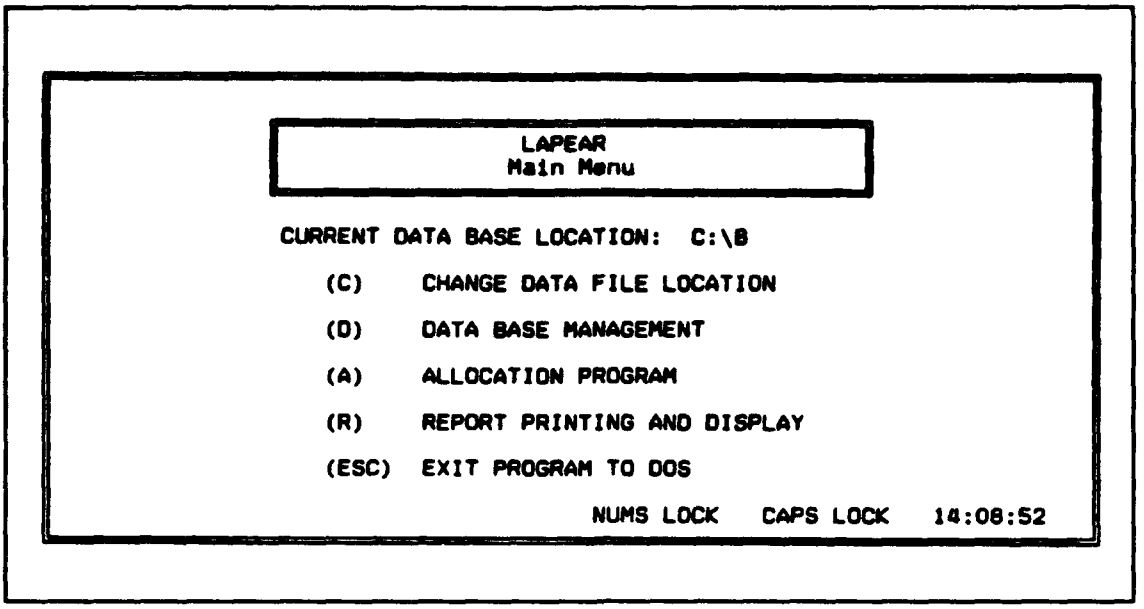
```
The directory C:\LAPEAR\DATA1 does not contain the required files.

 ENTER:

 (I)  If you will be initializing a new data set in this directory.

 (C)  To change data location.
```

Description: Informs the user that the given directory does not contain all of the data files required to run LAPEAR. This would be normal when initializing a new data base.

Entry: Entering "I" takes the user to the "INITIALIZE DATA BASE" portion of LAPEAR, and the user immediately will be prompted to begin entering data.

Entering "C" returns the user to the Data Location Screen.

0.3 Main Menu



Description: This menu allows the user to change to a different data base, or move among the three major portions of LAPEAR.

Options: Entering "C" takes the user to the Data Location Screen, to allow changing to a different data base.

Entering "D" takes the user to the Data Base Menu, for entering data and changing data in the current data base.

Entering "A" takes the user to the Allocation Program Execution Menu, for setting scenarios and running the LAPEAR optimization program.

Entering "R" takes the user to the Allocation Program Output Report Menu, for reviewing or printing generated output reports.

Entering "ESC", the ESCAPE key, allows the user to quit LAPEAR.

1.0 Data Location Screen

See Data Location Screen, paragraph 0.2.

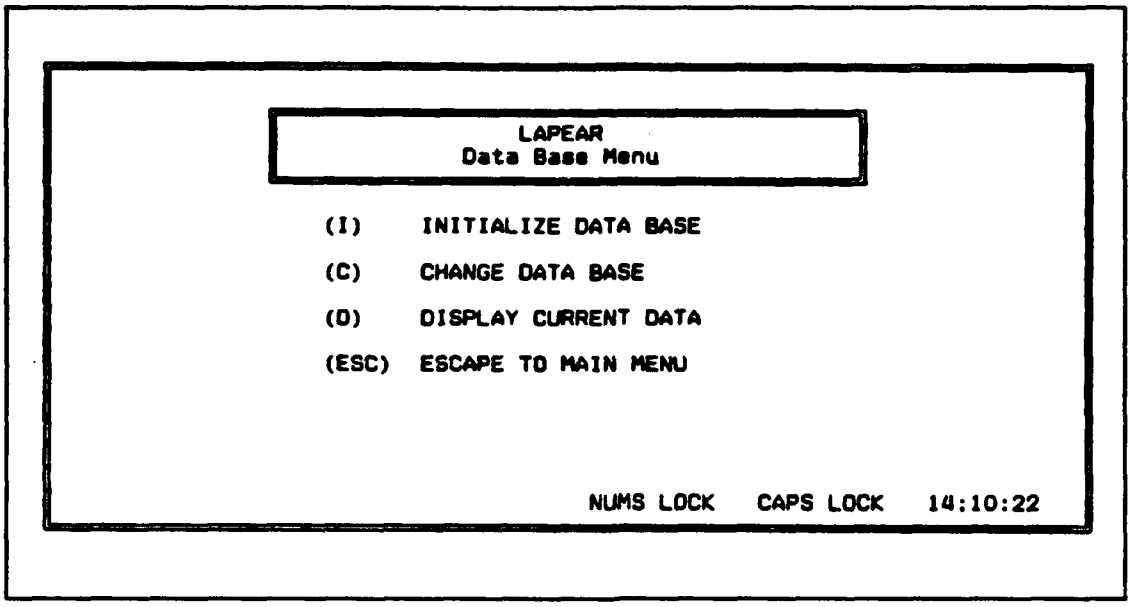
1.1 Data Location Verification

See Data Location Verification, paragraph 0.2.1.

1.2 Data Location Incomplete/Incorrect

See Data Location Incomplete/Incorrect, paragraph 0.2.2.

2.0 Data Base Menu



Description: This menu gives the user the opportunity to initialize a new data base, display data in the current data base, or change data in the current data base.

Options: Entering "I" allows the user to initialize a new data base in the current directory.

Entering "C" will give the user the Data Base Change Menu.

Entering "D" will give the user the Data Display Menu.

Using the "ESC" key will return the user to the Main Menu.

2.1.1 Data Base Initialization Warning Screens

```
WARNING!!!                          WARNING!!!

Running this option is designed to initialize all of the
data base files on the chosen directory.   Once  you begin
initialization, previous information in the current data base
will be lost.

If the data bases are already initialized, try using the
"CHANGE DATA BASE" option of the previous menu.

DO YOU WANT TO CONTINUE (Y/N)?
```

Description: This screen helps prevent the user from inadvertently initializing a new data base and destroying the existing data base in the current directory. This screen is followed by a second screen verifying the choice to initialize a new data set.

Entry: Entering "Y" allows the user to continue to initialize a new data base.

Entering "N" returns the user to the previous menu.

2.1.2 Nations Entry Screen

```
Enter two letter country code of participating nations.
(When finished, enter "END")...
```

Description: All nations that could provide support to any of the logistics sites are input here.

Entry: Two-letter abbreviation for each nation. For example, if the United States was one of the nations to be entered, "US" could be entered as an abbreviation. When all nations are input, enter "END" to continue to next screen.

2.1.3 Support Type Entry Screen

```
Enter all possible types of support required,
four letter code.  (When finished, enter "END")...
```

Description: All types of support that could be needed at any of the support sites are entered here.

Entry: Four-letter abbreviation for each type of support. For example, if a Shuttle Ship was one of the required types of support, "SHTL" could be used as an abbreviation. When all types of support are input, enter "END" to continue to next screen.

2.1.4 Area of Operations Entry Screen

```
Enter all possible areas of operations (two letter code).
(When finished, enter "END")...
```

Description: All possible areas of operations to be considered. Examples of these types of areas include WESTLANT, NORTHLANT, and BALTICS.

Entry: Four-letter abbreviation for each type of support. For example, "WL" could be used as an abbreviation for WESTLANT. When all areas of operations are input, enter "END" to continue to next screen.

2.1.5 Site-Type Location Entry Screen

```
Enter all possible MNLC sites in the WL area of operations,
using four letter code.  (When finished, enter 'END')
```

Description: All sites (cities) that could be used for the specified site-type for the specified area of operations. For example, NORFOLK could be designated as an MNLC for the WL area of operations. This screen will be repeated for every type of site (MNLC, ALSS, FLSS) and every area of operation.

Entry: Four-letter abbreviation for site. For example, if NORFOLK can be used as an MNCL in the WL area of operations, "NORF" could be entered. When all types of support are input, enter "END" to continue to next screen.

2.1.6 Site-specific Requirements Availability Entry Screen

Can US provide support to WL MNLC NORF (Y/N)?

Description: Determines if a nation can provide support to a specific logistics site. If so, LAPEAR will continue to ask how much of each type of support that the nation will provide to that site. If a nation will not provide support to that site, LAPEAR will go to the next nation/site combination. A specific logistics support site is determined by three parameters--the area of operations it supports, the type of support site it is, and the location of the site. For the above example, the site WLMNLCNORF represents the MNLC located in NORFOLK that supports the WESTLANT area of operations.

Entry: Enter "Y" if the specified nation can provide support to the specified site.

Enter "N" if the specified nation can not provide support to the specified site.

How many units of support item SHTL can US provide to WL MNLC NORF?

Description: Requests the amount of each type of support item a nation is willing to give to a specific site.

Entry: The amount of the support item the nation is willing to give to the specified site. This value must be an integer between 0 and 999. By pressing the enter key without entering a number, LAPEAR will assume a default value of 0.

2.1.7 Maximum Requirements Availability Entry Screen

What is the maximum amount of SHTL that US can provide?

Description: Requests the maximum amount of each type of support item a nation is willing to give to at a given time.

Entry: The maximum amount of the support item the nation is willing to give at a given time. This value must be an integer between 0 and 999. By pressing the enter key without entering a number, LAPEAR will assume a default value of 0.

2.1.8 Site-to-Nation Distance Entry Screen

What is the distance (in 100 KM) from NORF to US?

Description: The distance from each site (city) to each nation. High accuracy is not paramount for this entry, the purpose of this data is to serve as a "tie breaker" in the case of other priorities being equal. For example, if two nations have the same priority for providing SHTL to WL MNLC NORF, the nation with the shortest distance to NORF would be chosen.

Entry: This distance is rounded to the nearest hundred kilometer, and entered without the last two zeros (00). For example, a distance 1,200 KM would be entered as "12". Accordingly, this value must be an integer between 0 and 999. By pressing the enter key without entering a number, LAPEAR will assume a default value of 0.

2.1.9 Site Requirements Entry Screen

How many SHTL are needed at an MNLC?

Description: Determines how much of each type of support is required at each type of site. It is assumed during initialization that all MNLCs, all ALSSs, and all FLSs have the same requirements, independent of their specific location. In cases were the requirements differ, these values can be changed by using the Data Base Change section of the program.

Entry: Integer amount between 0 and 999, indicating how much of the particular type of support is required at a MNLC, ALSS, or FLS. By pressing the enter key without entering a number, LAPEAR will assume a default value of 0.

2.1.10 Shortage Penalty Entry Screen

Input penalty between 0 and 9 for having a shortage at an MNLC. (0 is no penalty, 9 is highest penalty)

Description: A penalty is assigned for having a shortage of an item at a support site, to ensure that all feasible requirements are met. In the case where a type of support is required at more than one type of site (MNLC, ALSS, FLSS), a priority can be set as to which type of site should be filled first: a site with a higher shortage penalty would be filled before a site with a lower one. After the data base is initialized, further changes can be made between specific locations or types of support by changing the appropriate values in the data file using the Data Base Change portion of the program.

Entry: Integer value between 0 and 9, indicating how much of a penalty should be applied for a shortage of an item at a particular type of site. By pressing the enter key without entering a number, LAPEAR will assume a default value of 0.

2.1.11 Priority Entry Screen

```
Can US provide support to WL MNLC NORF  (Y/N)?
```

Description: Determines if a nation can provide support to a specific logistics site. If so, LAPEAR will continue to ask what the priority is for that nation to provide support to that specific logistics site. If a nation will not provide support to that site, LAPEAR will go to the next nation/site combination.

Entry: Enter "Y" if the specified nation can provide support to the specified site.

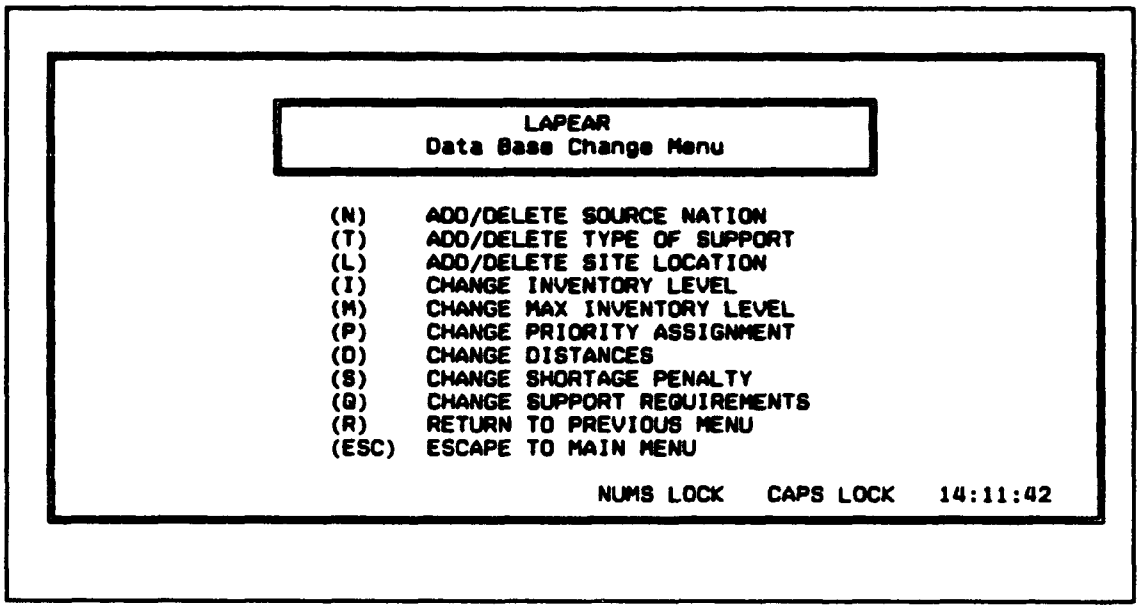
Enter "N" if the specified nation can not provide support to the specified site.

```
Enter priority between 1 and 9 for US providing support to WL MNLC
NORF?

   (1 is highest priority, 9 is least)
```

Description: Requests the priority for a nation providing support to a specific logistics site. The purpose of this priority is to give preference to one nation over another in providing support to a specific location. During initialization, this priority if given equally to all types of support from a nation to a site. If it is desired to assign different priorities based upon the types of support, this can be done in the Data Base Change part of the program.

Entry: Integer value between 1 and 9, where 1 is the highest priority and 9 is lowest. By pressing the enter key without entering a number, LAPEAR will assume a default value of 9 (lowest priority).

2.2 Data Base Change Menu



Description: This menu gives the user the opportunity to change data in the current data base. Additions and deletions are done by answering a series of questions and entering data where appropriate, while other changes are done with LAPEAR invoking the text editor.

Options: Entering "N" allows the user to add or delete a nation.

Entering "T" allows the user to add or delete a type of support.

Entering "L" allows the user to add or delete a site location.

Entering "I" allows the user to change the amount of support a nation is willing to provide to a specific location.

Entering "M" allows the user to change the maximum amount of support a nation is able to provide at a given time.

Entering "P" allows the user to change the priorities for a nation providing support to a specific location.

Entering "D" allows the user to change the distance from nations to sites.

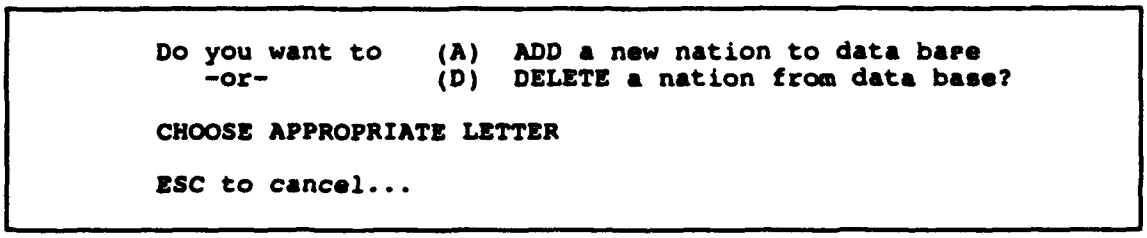
Entering "S" allows the user to change the penalty for having a shortage of a support item at a specific location.

Entering "Q" allows the user to change the amounts of support required at a specific site.

Entering "R" returns the user to the Data Base Menu.

Using the "ESC" key returns the user to the Main Menu.

2.2.1 Adding/Deleting Nations Screens

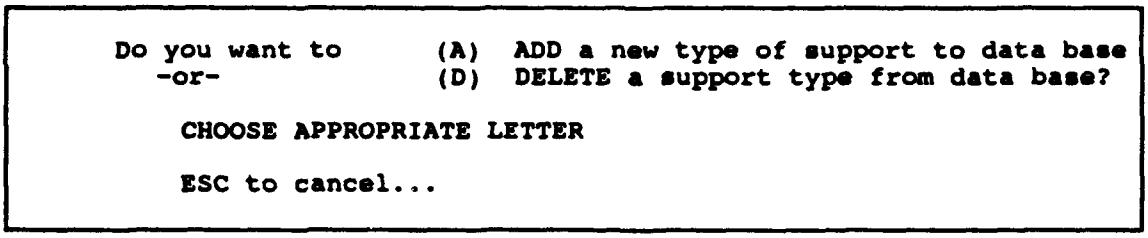


Description: Allows user to add a new nation or delete an existing nation from the data base.

Entry: Enter "A" to ADD a new nation. This will lead you through a series of questions similar to those in entry screens 2.1.2, 2.1.6 - 2.1.8, and 2.1.11.

Enter "D" to delete an existing nation.

2.2.2 Adding/Deleting Types of Support Screens

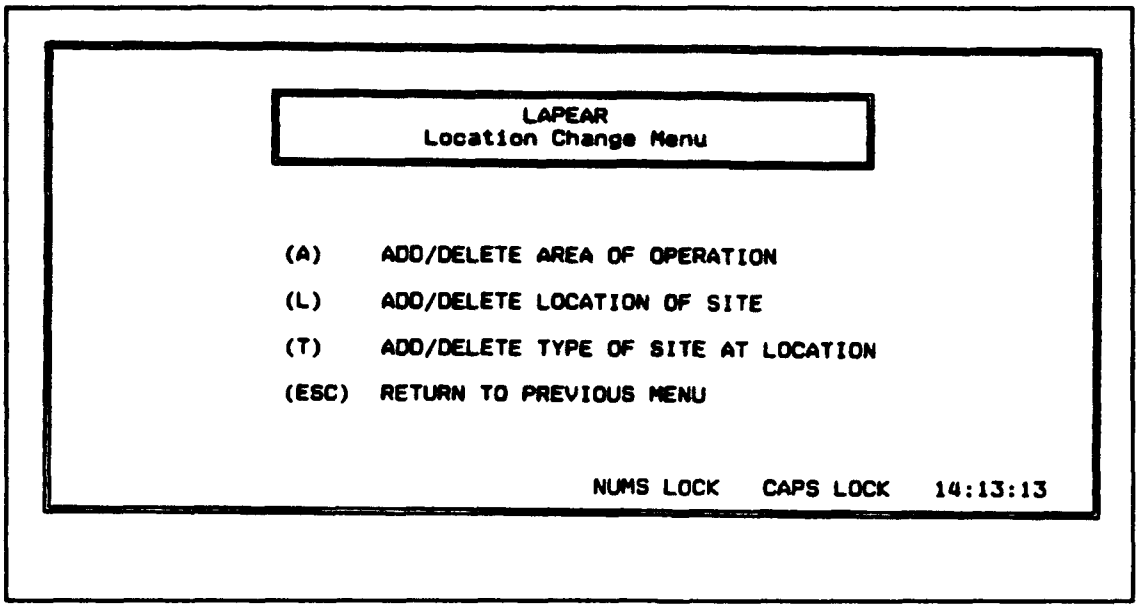


Description: Allows user to add a new type of support or delete an existing type of support from the data base.

Entry: Enter "A" to ADD a new type of support. This will lead you through a series of questions similar to those in entry screens 2.1.3, 2.1.6, and 2.1.9 - 2.1.11.

Enter "D" to delete an existing type of support.

2.2.3 Location Change Menu



Description: A specific location consists of three parts: the area of operation it supports, the type of site, and the city where the site is located. Any of these three can be added or deleted from this menu.

Options: Entering "A" allows the user to add a new area of operations and input all associated data, or delete all locations associated with an existing area of operations.

Entering "L" allows the user to add a new city for a site location, and input all associated data, or delete all locations located in an existing city.

Entering "T" allows the user to add or delete a type of site located at a specific location.

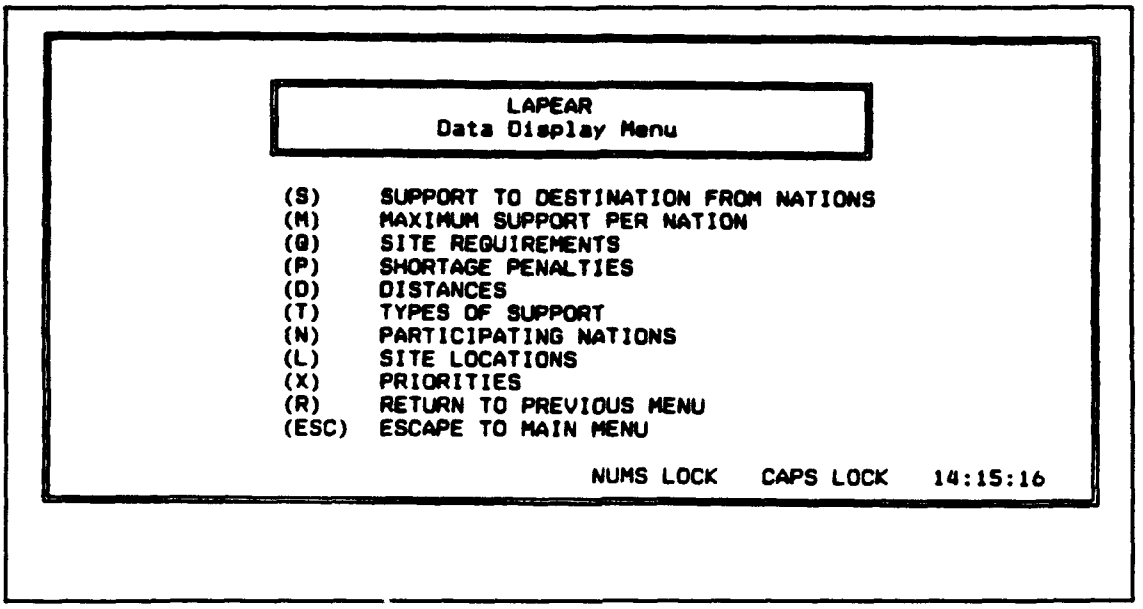
Entering "ESC" returns the user to the Data Base Change Menu.

Follow-up Actions: After entering one of the above options, the user is given the choice of adding or deleting a location.

When adding a location, the user will input the information necessary to identify the location(s) being added and all associated data similar to that in screens 2.1.2-2.1.11.

When deleting an Area of Operations or Location of Site, all locations associated with those parameters will be deleted. When deleting a Type of Site at a Location, only one specific location will be deleted.

2.3 Data Display Menu



Description: This menu allows the user to view the various data files. Since this display is accomplished by use of the text editor, it is possible to change data in these files. The user is cautioned to change only existing numeric data, and ensure that the left-justification format is followed.

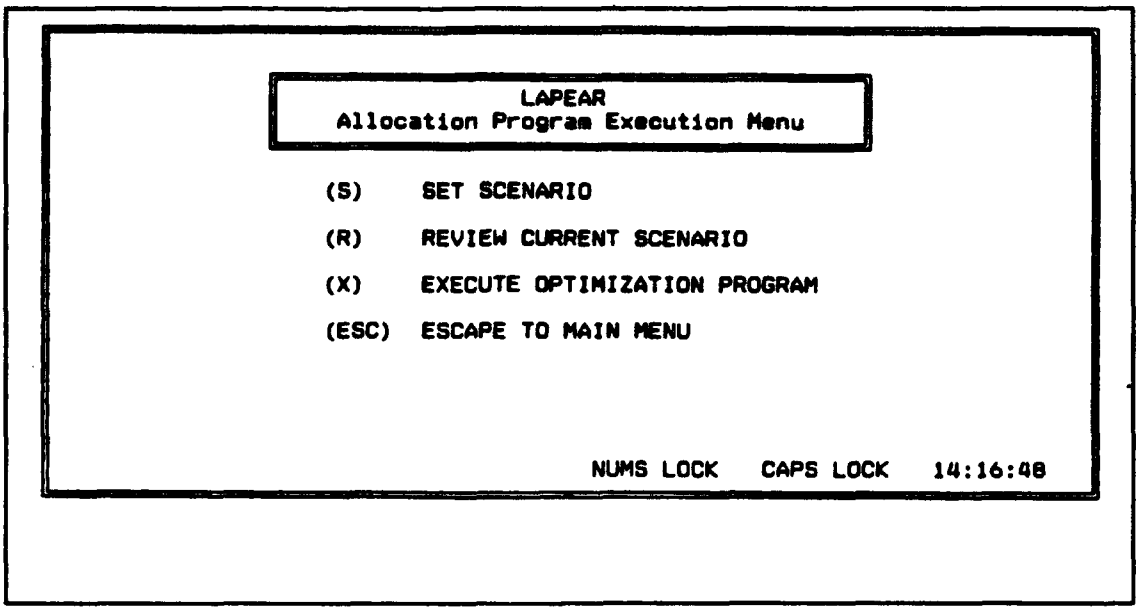
Options: Entering "R" will return the user to the Data Base Menu.

Entering "ESC" will take the user to the Main Menu.

Entering any of the other available choices will display the associated data.

ERROR POTENTIAL: Changing any information in these files other than numeric data, or altering the columnar structure and/or left justification, will make the data file invalid. Use caution when displaying data files.

3.0 Allocation Program Execution Menu

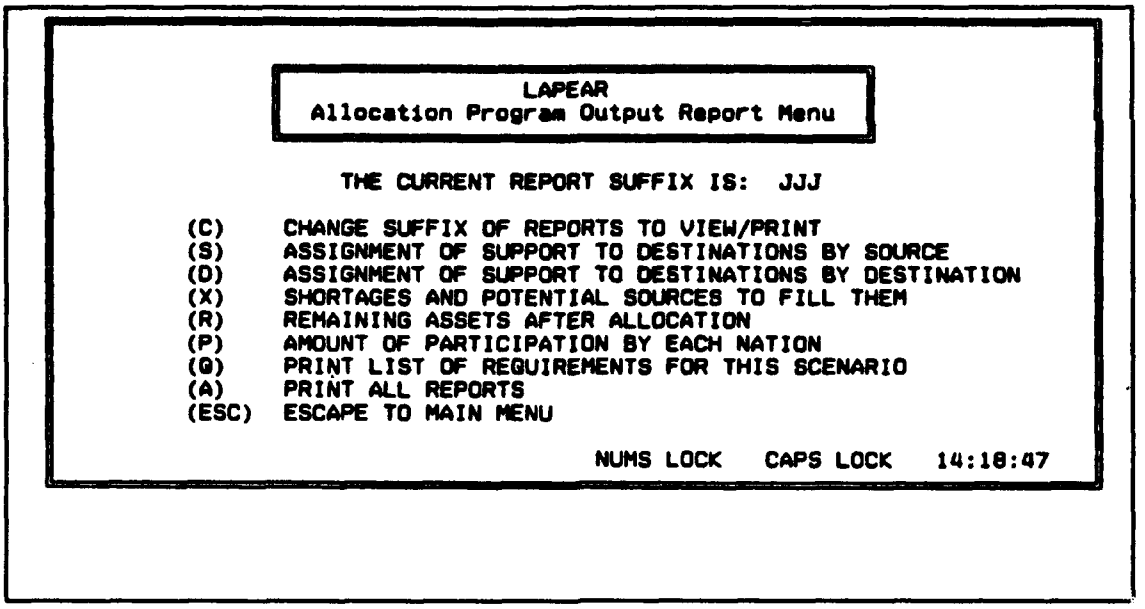


Description: This menu allows the user to set a scenario to be evaluated, review the current scenario, and run the GAMS optimization of the specified scenario.

Options: Entering "S" allows the user to choose the locations and participating nations for a given scenario. Entering "R" allows the user to review the locations and participating nations in the current scenario.

Entering "X" runs the GAMS optimization program on the current scenario and generates the various output reports. When making this selection, the user will be prompted for a three-letter suffix to attach to the output reports. This suffix will distinguish these reports from previously generated ones. For example, "WL1" could be entered to indicate the first scenario in the WESTLANT area of operations.

4.0 Report Printing and Display Menu



Description: This menu allows review of current and previously-generated output reports from the current data base. The reports selected will be those with the suffix indicated on the menu. After selecting a report to review, the user will be given the option of printing the report or displaying it on the screen.

Options: Entering "C" allows the user to review previously generated reports by changing to the appropriate report suffix. After selecting this option, the user will be asked to input the three letter suffix for those previous reports.

Entering "S" allows the user to review the list of how much of each type of support each nation will provide to each support site.

Entering "D" allows the user to review the list of how much of each type of support a site will receive from each nation.

Entering "X" allows the user to review the list of shortages and potential nations to fill those shortages.

Entering "R" allows the user to review the list of all assets each nation has remaining after the most recent optimization run.

Entering "P" allows the user to review the number of support each nation is providing.

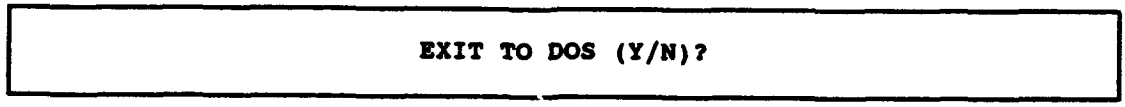
Entering "Q" prints out a list of the support item requirements at each support site in the current scenario.

Entering "A" prints out all output reports.

Entering "ESC" returns user to the Main Menu.

ERROR POTENTIAL: The printer must be designated to run on LPT1, and MUST BE TURNED ON prior to trying to print output reports. Otherwise, LAPEAR could abort.

5.0 Exit Program to DOS Verification Screen



Description: This screen allows the user to verify that it is desired to exit LAPEAR.

Entry: Entering "Y" will allow the user to exit LAPEAR.

Entering "N" will return the user to the Main Menu.

V. SAMPLE MNLF DATA

The following are examples of the types of information required to initialize a data base with LAPEAR.

LOGISTICS SITES

	WL	EL	NL	BA	IB	AW	AE
MNLC'S	NORF	PORT	VAER	STAV	AZOR	CART	SOUD
	HALI	KEFL	PRES	ZEEB	LISB	SIGO	INCI
		PRES	KEFL	DENH	ROTA	LISB	AKSA
			KVER	KIEL	LASP	ROTA	
			STAV	PRES			
				PORT			
ALSS'S	NORF	PORT	VAER	STAV	AZOR	CART	SOUD
	HALI	KEFL	PRES	ZEEB	LISB	SIGO	INCI
		PRES	KEFL	DENH	ROTA	LISB	AKSA
			KVER	KIEL	LASP	ROTA	
			STAV	PRES			
				PORT			
FLS'S	NORF	PORT	ANDO	FRIE	AZOR	CART	SOUD
	HALI	KEFL	BODO	STAV	LISB	SIGO	INCI
		PRES	VAER	DENH	ROTA	LISB	AKSA
		SUMB	SUMB	ZEEB	LASP	ROTA	
			PRES	ESBJ			
			KVER	PRES			
			BROE	KIEL			
			EVEN	PORT			
			STAV				

LOGISTICS SUPPORT SITE REQUIREMENTS

	MCSR	MADM	AOPS	SOPS	MOPS	VOQS	COQS	TAIF	SRTL	AOQR	AACQ	ASCQ	ACQM	AMED	FCQR	FACQ	FSCQ	FCQM	FMEC
MNLS	1	1	1		1	4	1												
ALSS										1	3	3	1	1					
FLS															1	2	2	1	1

MAXIMUM INVENTORY

	MNLC								ALSS						FLS			
	MCOR	MADM	AOPS	SOPS	MOPS	VOOS	COOS	AIR	SPT	ACOR	AACO	ASCO	ACOM	AMED	FCOR	FACO	FSCO	FCOM	FMED
BE	0	1	0	1	1	0	0	1	0	0	1	1	0	1	0	1	1	0	1
CA	1	1	0	0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1
DE	0	1	0	1	1	0	0	1	0	0	1	1	0	1	0	1	1	0	1
GE	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
GR	0	1	0	1	1	0	0	1	0	0	1	1	0	1	0	1	1	1	1
IT	0	1	0	1	1	0	0	1	0	0	1	1	0	1	0	1	1	0	1
NE	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
NR	0	1	0	1	1	0	0	0	1	1	0	1	0	1	1	1	1	0	1
PO	0	1	0	0	0	0	0	1	0	0	1	1	0	0	0	1	1	1	0
SP	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	1	1	1
TU	1	1	0	1	0	0	0	0	1	1	0	1	1	1	1	0	1	1	1
UK	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
US	2	2	2	2	2	4	4	8	8	2	2	2	2	2	3	3	3	3	3

INVENTORY

	MNCC										ALSS									
	MCOR	MAOM	AOPS	SOPS	MOPS	VCOS	COOS	CAIR	SHYC	TACOM	AACS	ESCO	TACOM	AMEL	FCOM	FACS	TESCO	FCOM	FMED	
BEWL	0	1	0	1	1	0	0	1	0	1	1	1	0	1	0	1	1	1	1	
BEEL	0	1	0	1	1	0	0	1	0	1	1	1	0	1	0	1	1	1	1	
BENL	0	1	0	1	1	0	0	1	0	1	1	1	0	1	0	1	1	1	1	
BESA	0	1	0	1	1	0	0	1	0	1	1	1	0	1	0	1	1	1	1	
CAWL	1	1	0	0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	
CAEL	1	1	0	0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	
CANL	1	1	0	0	1	0	0	0	0	1	1	1	1	1	1	1	1	1	1	
DEWL	0	1	0	1	1	0	0	1	0	0	1	1	0	1	0	1	1	0	1	
DEEL	0	1	0	1	1	0	0	1	0	0	1	1	0	1	0	1	1	0	1	
DENL	0	1	0	1	1	0	0	1	0	0	1	1	0	1	0	1	1	0	1	
DESA	0	1	0	1	1	0	0	1	0	0	1	1	0	1	0	1	1	0	1	
GEWL	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	
GEEL	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	
GENL	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	
GESA	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	
GEIB	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	
GEAW	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	
GEAE	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	
GRAE	0	1	0	1	1	0	0	1	0	0	1	1	0	1	0	1	1	1	1	
ITIS	0	1	0	1	1	0	0	1	0	0	1	1	0	1	0	1	1	0	1	
ITAW	0	1	0	1	1	0	0	1	0	0	1	1	0	1	0	1	1	0	1	
ITAE	0	1	0	1	1	0	0	1	0	0	1	1	0	1	0	1	1	0	1	
NEWL	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	
NEEL	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	
NENL	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	
NESA	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	
NRNL	0	1	0	1	1	0	0	0	1	1	0	1	0	1	1	0	1	1	1	
NRSA	0	1	0	1	1	0	0	0	1	1	0	1	0	1	1	0	1	1	1	
POWL	0	1	0	0	0	0	0	1	0	0	1	1	0	0	0	1	1	1	0	
POEL	0	1	0	0	0	0	0	1	0	0	1	1	0	0	0	1	1	1	0	
PONL	0	1	0	0	0	0	0	1	0	0	1	1	0	0	0	1	1	1	0	
POIB	0	1	0	0	0	0	0	1	0	0	1	1	0	0	0	1	1	1	0	
POAW	0	1	0	0	0	0	0	1	0	0	1	1	0	0	0	1	1	1	0	
POAE	0	1	0	0	0	0	0	1	0	0	1	1	0	0	0	1	1	1	0	
SPWL	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	1	1	1	
SPEL	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	1	1	1	
SPNL	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	1	1	1	
SPIB	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	1	1	1	
SPAW	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	1	1	1	
SPAE	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	1	1	1	
TUIB	1	1	0	1	0	0	0	0	1	1	0	1	1	1	1	0	1	1	1	
TUAW	1	1	0	1	0	0	0	0	1	1	0	1	1	1	1	0	1	1	1	
TUAE	1	1	0	1	0	0	0	0	1	1	0	1	1	1	1	0	1	1	1	
UKWL	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	
UKEL	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	
UKNL	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	
UKSA	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	
UKIB	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	
UKAW	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	
UKAE	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	
USWL	1	1	1	1	1	2	2	8	6	1	1	1	1	1	2	2	2	2	2	
USEL	1	1	1	1	1	2	2	8	6	1	1	1	1	1	2	2	2	2	2	
USNL	1	1	1	1	1	2	2	8	6	1	1	1	1	1	2	2	2	2	2	
USBA	1	1	1	1	1	2	2	8	6	1	1	1	1	1	2	2	2	2	2	
USIB	1	1	1	1	1	2	2	8	6	1	1	1	1	1	2	2	2	2	2	
USAW	1	1	1	1	1	2	2	8	6	1	1	1	1	1	2	2	2	2	2	
USAE	1	1	1	1	1	2	2	8	6	1	1	1	1	1	2	2	2	2	2	

DISTANCE (100 KM'S)

	BE	CA	DE	GE	GR	IT	NE	NR	PO	SP	TU	UK	US
NORF	85	15	88	88	105	95	87	95	72	75	110	80	0
HALI	72	0	75	75	90	75	70	75	50	55	100	65	20
PORT	8	65	12	13	14	20	9	14	20	20	45	0	80
KEFL	28	50	28	30	50	40	28	25	33	33	65	15	75
PRES	8	65	12	13	14	20	9	14	20	20	45	0	80
SUMB	8	65	12	13	14	20	9	14	20	20	45	0	80
VAER	13	75	5	15	30	25	10	0	30	30	40	14	95
KVER	13	75	5	15	30	25	10	0	30	30	40	14	95
STAV	13	75	5	15	30	25	10	0	30	30	40	14	95
ANDO	13	75	5	15	30	25	10	0	30	30	40	14	95
BODO	13	75	5	15	30	25	10	0	30	30	40	14	95
BROE	13	75	5	15	30	25	10	0	30	30	40	14	95
EVEN	13	75	5	15	30	25	10	0	30	30	40	14	95
ZEEB	0	72	8	5	20	12	3	13	18	18	30	8	85
DENH	3	70	5	2	20	12	0	10	20	20	30	9	87
KIEL	20	90	5	0	20	15	20	30	40	40	30	14	105
FRIE	20	90	5	0	20	15	20	30	40	40	30	14	105
ESBJ	8	75	0	5	30	18	5	5	40	40	35	12	88
AZOR	18	50	45	45	55	50	20	30	0	25	45	20	72
LISB	18	50	40	40	50	40	20	30	0	5	40	20	72
ROTA	18	55	40	40	30	20	20	30	10	0	35	20	75
LASP	18	55	40	40	30	20	20	30	10	0	35	20	75
CART	18	55	40	40	30	20	20	30	10	0	35	20	75
SIGO	12	75	18	15	10	0	12	25	25	18	20	20	95
SOUD	20	90	30	20	0	10	20	30	32	25	20	14	105
INCI	30	100	35	30	10	20	30	40	40	35	0	45	110
AKSA	30	100	35	30	10	20	30	40	40	35	0	45	110

PRIORITIES

	WL	EL	NL	BA	IB	AW	AE
BE	9	2	6	2			
CA	2	9	9				
DE	6	6	2	2			
GE	9	2	2	2	6	4	9
GR							2
IT					6	2	2
NE	9	6	2	2			
NR			2	2			
PO	9	6	9		2	2	6
SP	9	6	9		2	2	6
TU					9	6	2
UK	4	2	2	4	4	4	4
US	2	4	6	6	4	4	4

SHORTAGE PENALTY	
MNLC	8
ALSS	6
FLS	4

VI. OUTPUT REPORTS

LAPEAR generates five output reports to assist in resource allocation planning. The allocation plan provided is based on user inputs of availability and assigned cost. Due to the subjectivity of the costs, however, the results should be given a "common sense" test to make sure that the NATO Commander's desires are actually being met. The values assigned in the "preference" data can easily be changed if necessary to more accurately reflect the commander's desires, and the model then can be run again. Following are samples of each type of report, with accompanying explanations.

Assignment of Support by Source

ASSIGNMENT OF SUPPORT BY SOURCE

SOURCE	DESTINATION	SUPPORT	AMOUNT
BE			
	BAALSSSTAV	AACD	1
	BAALSSSTAV	ASCD	1
DE			
	BAMNLCSTAV	MADM	1
	BAMNLCSTAV	SOPS	1
	BAMNLCSTAV	MOPS	1
	BAMNLCSTAV	TAIR	1
	BAALSSSTAV	AACD	1
	BAALSSSTAV	ASCD	1
	BAALSSSTAV	AMED	1
	BAFLSSFRIE	FACD	1
	BAFLSSFRIE	FSCD	1

This report lists the amount of each type of support provided to the various sites by each nation. For example, nation BE is providing one unit of support item AACD to the site BAALSSSTAV.

Assignment of Support by Destination

ASSIGNMENT OF SUPPORT BY DESTN

	SUPPORT	SOURCE	AMOUNT
BAMNLCSTAV			
	MCDR	NE	1
	MADM	DE	1
	AOPS	NE	1
	SOPS	DE	1
	MOPS	DE	1
	VODS	GE	1
	VODS	NE	1
	VODS	UK	1
	CODS	US	1
	TAIR	DE	1
	SHTL	NE	1

This report lists the amount of each type of support each nation will be providing to a specific site. For example, site BAMNLCSTAV receives one unit of support item MCDR from nation NE.

Listing of Shortages by Destination, and Potential Sources to Fill Shortages

```
LISTING OF SHORTAGES BY DESTN

     BAMNLCSTAV      VODS          1


  POTENTIAL SOURCES TO FILL SHORTAGES

SUPPORT      SOURCE       AMT AVAILABLE

 VODS         IT               1
```

This report lists the requirements that could not be filled, and any nation that could potentially provide that support. In this example, site BAMNLCSTAV is short one unit of support item VODS. Nation IT has one unit of VODS available, but apparently was not initially willing to provide it to site BAMNLCSTAV.

List of Remaining Assets

LISTING OF REMAINING ASSETS TO GIVEN AREA, AND MAX ASSETS REMAINING

SOURCE	SUPPORT	DESTIN	AVAIL TO DESTN	MAX AVAILABLE
BE	MADM	BAMNLCSTAV	1	1
BE	SOPS	BAMNLCSTAV	1	1
BE	MOPS	BAMNLCSTAV	1	1
BE	TAIR	BAMNLCSTAV	1	1
BE	AMED	BAMNLCSTAV	0	1
BE	FACD	BAMNLCSTAV	0	1
BE	FSCD	BAMNLCSTAV	0	1
BE	FMED	BAMNLCSTAV	0	1

This report lists all assets each nation has remaining after the allocation is performed, and which sites the nation is willing to provide the assets to. For example, nation BE has one unit of support item MADM left and is willing to give it to site BAMNLCSTAV. BE also has one unit of FMED left, but is not willing to give it to BAMNLCSTAV.

Participating Nations

PARTICIPATING NATIONS

NATION	UNITS PROVIDED
BE	2
DE	9
GE	6
GR	8
IT	3
NE	8
TU	9
UK	4
US	6

This report lists the total number of support items each nation is providing to the MNLFs in the given scenario.

VII. POTENTIAL PROBLEMS

This program has only been tested with MS-DOS 5.0. Other versions of MS-DOS should work, but some other operating systems may not.

This program requires a text editor accessed by the command EDIT. This editor is standard in MS-DOS.

Entering the incorrect disk drive could cause LAPEAR to abort during program operation.

Changing any information in the data files other than numeric data, or altering the columnar structure and/or left justification, will make the data file invalid. Use caution when displaying and/or changing data files.

The printer must be designated to run on LPT1, and must be turned on prior to trying to print output reports. Otherwise, LAPEAR could abort.

VIII. RESERVED WORDS

There are certain words reserved for use by GAMS which may not be used when determining abbreviations for nations, types of support, and locations. A representative list of two and four letter words, which could provide potential conflicts, follows. For a complete listing, consult the documentation with your version of GAMS[1]

EQ	CARD
GE	FREE
GT	LOOP
LE	PROD
LT	SETS
NA	SMAX
NE	SMIN
NO	SOS1
OR	SOS2

[1]From GAMS, A User's Guide, release 2.25, Anthony Brooke, David Kendrick, Alexander Meeraus, Published by The Scientific Press, South San Francisco, CA, p. 40; 1992

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